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Printed on Thin Paper for Foreign Circulation.

"THE ENGINEER," AUGUST 27, 1926

With METALLURGICAL SUPPLEMENT.

The Engineer.

Established 1856.

Registered as a Newspaper.

OFFICE FOR ADVERTISEMENTS & PUBLICATION, 33, NORFOLK ST., STRAND, LONDON, W.C. 2.

VOL. CXLII.—No. 3685] LONDON: FRIDAY EVENING, AUGUST 27, 1926 [PRICE {WITH SUPPLEMENT} ONE SHILLING BY INLAND POST 1s. 3d.

The Engineer

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PUBLIC NOTICES

TO BUILDERS.

The Commissioners of His Majesty's Works, &c., are prepared to receive TENDERS before 11 a.m. on Tuesday, 14th September, 1926, for the SUPPLY and ERECTION of a WOOD PRESERVATION PLANT at the Forest Products Research Laboratory, Princes Risborough, Bucks.

Drawings, specification, a copy of the conditions and form of contract and forms for Tender may be obtained from the CONTRACTS BRANCH, H.M. Office of Works, King Charles-street, London, S.W. 1, on payment of One Guinea. (Cheques payable to the Commissioners of H.M. Works, &c.) The sums so paid will be returned to those persons who send in Tenders in conformity with the conditions. 3403

The Director - General, India Store Department, Branch No. 15, Belvedere-road, Lambeth, S.E. 1, invites TENDERS for :—

1. 4572 FEET STEEL WELL BORING TUBES and SOCKETS, 16in., 14in., and 12in. diameter.
2. About 1100 TONS of ORDINARY STEEL RAILS and about 1100 TONS of SANDBERG SORBITIC RAILS.
3. ONE 300 K.W. D.C. STEAM SET, with Boiler, Condenser, Cooling Tower and Auxiliaries and Switchboard, &c., complete, for Peshawar Cantonment Power Station.
4. COPPER TUBING (about 12 Tons).
5. 12 VERTICAL CROSS-TUBE BOILERS, 12ft. by 4ft. 6in., 100 lb. pressure.

Tenders due on the 7th September, 1926, for No. 1, on the 10th September, 1926, for Nos. 2 and 3, on the 14th September, 1926, for No. 4, and on the 17th September, 1926, for No. 5.

Specifications and forms of Tender obtainable from the above at a fee of 5s. per set, which will not be returned. 3424

The Director - General, India Store Department, Branch No. 15, Belvedere-road, Lambeth, S.E. 1, invites TENDERS for :—

1. About 900 TONS ROLLED STEEL KEYS for SLEEPERS.
2. 39 BOGIE TRUCKS for RAILWAY STOCK.
3. 12 HIGH-SIDED WAGONS and 9 PLATFORM TRUCKS for 2ft. 6in. gauge.

Tenders due on the 14th September, 1926.

Specifications and forms of Tender obtainable from the above at a fee of 5s. per set, of which will not be returned. 3425

A Vacancy occurs for a JUNIOR TECHNICAL OFFICER in the Aerodynamics Department of the Royal Aircraft Establishment. The work will involve flying as observer and candidates must be medically fit for flying. The minimum qualifications necessary are Hons. Degree in Natural or Mechanical Science. Preference will be given to ex-Service candidates and to candidates with aeronautical training or experience. Salary £175-15-£235 p.a., giving starting rate of approximately £266 p.a.

Applications must be made on form to be obtained from the EMPLOYMENT DEPARTMENT, Royal Aircraft Establishment, Farnborough, Hants, to whom it should be returned (quoting reference A. 122) not later than 18th September, 1926. 3190

Temporary Draughtsman REQUIRED, with thorough knowledge of Building Construction in all its branches, Surveying and Levelling.

Ex-Service man preferred.

Apply, stating age, experience, qualifications, and salary required, with copies of at least two recent testimonials, to

OFFICER IN CHARGE OF WORKS,
3417 H.M. Naval Base, Portland.

Armstrong College,
NEWCASTLE-UPON-TYNE.
(IN THE UNIVERSITY OF DURHAM.)

COURSES for the PASS DEGREE of B.SC. and the HONOURS DEGREE of B.SC. in MECHANICAL, MARINE, CIVIL or ELECTRICAL ENGINEERING, MINING, METALLURGY, or NAVAL ARCHITECTURE. The curricula of the Pass Degree and the Honours Degree normally occupy periods of three and four years respectively, but candidates presenting evidence of sufficient previous training may be allowed to proceed to either Degree after two years' residence.

The engineering laboratories have recently been extended, and all Departments are equipped for advanced tutorial and research work.

The NEXT SESSION COMMENCES on 5th OCTOBER, 1926.

Full particulars of the Courses may be had on application to

THE REGISTRAR,
Armstrong College,
2512 Newcastle-upon-Tyne.

Chelsea Polytechnic.
MANRESA-ROAD, CHELSEA, S.W. 3.
SPECIAL CLASSES IN ENGINEERING METALLURGY.

In addition to the Courses in General Metallurgy, arrangements have been made for Special Courses of Lectures and Practical Work :—

(a) Engineering Metallurgy. Syllabus arranged to cover the syllabus of the Institute of Mechanical Engineers Associateship Examination in Metallurgy ;
(b) Heat Treatment of Metals ;
(c) Testing and Mechanical Working of Metals.

The above classes are suitable for Engineers, Consultants, Engineering Students, Works Metallurgists.

Full details on application.

Tels., 0690 and 8007 Kensington.

COURSES BEGIN 20th SEPTEMBER, 1926. 3189

PUBLIC NOTICES

City of Cardiff Education COMMITTEE.
THE TECHNICAL COLLEGE.
Principal : CHARLES COLES, B.Sc. (Lond.).
DEPARTMENT OF ENGINEERING.
Head of Department : A. W. LOVERIDGE, B.Sc. (Eng.), A.R.C.Sc.
SESSION 1926-7.
Commencing on Tuesday, 5th October, 1926.

The following Courses have been arranged for Engineering Students :—

A Three Years' Course in Mechanical and Marine Engineering jointly with the University College of South Wales and Monmouthshire.
A Two Years' Course for Apprentices and others with facilities for practical experience in the Summer Term.

These Courses are suitable for students preparing for Degrees in Engineering or for the Examinations of the Engineering Societies.

Special Courses are also arranged for Marine Engineers preparing for the Examinations of the Board of Trade.

OPEN SCHOLARSHIPS, covering tuition fees and maintenance grants of £40 per annum for three years, are offered for competition annually and candidates for entry to the above Department are eligible to compete.

For further particulars of Full-time and Part-time Courses, Entrance Examination, Scholarships, Fees, &c., apply to the Principal. Application forms for Entrance Scholarship Examination, duly filled up, must be received before September 18th.

JOHN J. JACKSON,
Director of Education.
City Hall, Cardiff. 3195

University of Manchester.
PHYSICS DEPARTMENT.

Full particulars of the LECTURES and LABORATORY COURSES in PHYSICS, preparing for both the Ordinary and the Honours Degrees, will be forwarded on application to the REGISTRAR. 3199

University of Manchester.
DEPARTMENT OF ELECTRICAL ENGINEERING.
DEPARTMENTS OF CIVIL, MECHANICAL AND ELECTRICAL ENGINEERING.

Full particulars of these COURSES will be forwarded on application to the REGISTRAR. The Session commences on October 7th. 3128

PUBLIC NOTICES

Borough Polytechnic Institute, BOROUGH-ROAD, LONDON, S.E. 1.
ENGINEERING QUANTITIES AND ESTIMATES.

The Governors REQUIRE the SERVICES in September of VISITING LECTURER in the above-named subject. Candidates must have had actual practical experience in the work. Form of application and further particulars may be obtained by sending stamped addressed envelope to the undersigned.

J. W. BISPHAM,
3191 Principal.

The Polytechnic, 309, Regent STREET, W. 1.
STUDENTSHIP EXAMINATION OF THE INSTITUTION MECHANICAL ENGINEERS.
PRELIMINARY EXAMINATION, INSTITUTION OF CIVIL ENGINEERS.
FINAL EXAMINATION, INSTITUTION ELECTRICAL ENGINEERS (PART I).

Special Courses have been arranged for Students taking the above Examinations. The syllabus covers all the work in PURE MATHEMATICS, MECHANICS, PHYSICS, ENGLISH and FRENCH.

Fee for the Course, £2 2s.

Prospectus free on application to the DIRECTOR OF EDUCATION. 3189

The Polytechnic, 309, Regent STREET, W. 1.
SCHOOL OF ENGINEERING.

President of the School : The Hon. Sir CHARLES PARSONS, K.C.B., M.A., LL.D., D.Sc., F.R.S., &c.
Head of Department : ALEX. P. HORNE, O.B.E., B.Sc. (Hons. Eng.), F.R.S. (Edin.), &c.

The DAY DEPARTMENT RE-OPENS on SEPTEMBER 21st, 1926. Entrance Examination commences September 6th, 1926, at 9.30 o'clock.

Three-year DIPLOMA COURSES in
MECHANICAL ENGINEERING.
ELECTRICAL ENGINEERING.
MOTOR CAR ENGINEERING.

Practice in the Laboratories, Drawing-office, Workshop and Field.

Fee 21 Guineas per annum.

THE EVENING DEPARTMENT re-opens on September 27th, 1926. Students enrolled from September 15th, 1926.

The Day and Evening Courses are recognised for the Diplomas and Certificates issued by the Institutions of Mechanical and Electrical Engineers in conjunction with the Board of Education.

Full prospectus free on application to the DIRECTOR of EDUCATION. 3080

PUBLIC NOTICES

UNIVERSITY OF LONDON.
King's College.
FACULTY OF ENGINEERING.

COMPLETE COURSES of STUDY, extending over either three or four years, are arranged in CIVIL, MECHANICAL and ELECTRICAL ENGINEERING for the Engineering Degrees of the University of London and for the Diploma and Certificate of the College.

The four years' Course provides, in addition to the academic training, opportunity for practical training in "Works."

HEADS OF DEPARTMENTS.

Professor G. COOK, D.Sc., M.I. Mech. E., A.M. Inst. C.E., Mechanical Engineering.
C. A. GENEVE, B.Sc., A.M.I. Mech. E., Senior Lecturer.
Professor A. H. JAMESON, M.Sc., M. Inst. C.E., Civil Engineering (Dean).
C. H. LOBBAN, D.Sc., A.M. Inst. C.E., Senior Lecturer.
Professor E. WILSON, M. Inst. C.E., M.I.E.E., Electrical Engineering.
F. S. ROBERTSON, M.I.E.E., Lecturer.
Professor S. A. F. WHITE, M.A. } Mathematics.
Professor A. E. JOLLIFFE, M.A. }

Considerable extensions have been made in the Engineering Department. These include a large additional drawing-office, lecture room and laboratory for Hydraulics and Strength of Materials in the Civil and Mechanical Departments, and research rooms, including Wireless Telegraphy, in the Electrical Engineering Department. Large additions have been made to the equipment of the Laboratories in the three Departments for purposes of teaching and research.

There is a College Hostel and a large Athletic Ground.

For full information apply to the SECRETARY, King's College, Strand, W.C. 2. 2979

Northampton Polytechnic INSTITUTE.
St. John-street, London, E.C. 1.
SESSION 1926-7.
ENGINEERING DAY COLLEGE.

The College provides courses in Civil, Mechanical, Electrical, Aeronautical, and Radio Engineering.

Each course occupies four years and includes provision for students to spend two summer periods, April to September, in commercial works.

Matriculated students are able to enter as Internal Candidates for the examinations leading to Degrees in Engineering of the University of London.

Students should be not less than sixteen years of age at entrance.

An entrance examination in English and Mathematics will be held on Thursday and Friday, September 9th and 10th. Classes commence Monday, September 27th.

TUITION FEES.—£18 per annum for students residing in London, Kent or Middlesex ; £60 for students resident elsewhere.

Three entrance scholarships, each of the value of £18 per annum, are offered for competition at the entrance examination.

A prospectus giving full particulars will be forwarded on application to the PRINCIPAL. 3187

Northampton Polytechnic INSTITUTE.
ST. JOHN-STREET, E.C. 1.

Evening Courses in ENGINEERING and in FUEL TECHNOLOGY and METALLURGY (including Metallography) for Engineers, Engineering Chemists, &c., commence on Monday, September 20th, 1927.—Prospectuses may be obtained from the PRINCIPAL. 3186

COUNTY BOROUGH OF WEST HAM.
West Ham Municipal College.
SESSION 1926-27.

DAY and EVENING COURSES in CIVIL, MECHANICAL, and ELECTRICAL ENGINEERING, under recognised teachers of London University.

Matriculated Students are recognised as "Internal" Students of the University.

Enrolment of students, September 13th to 17th.

Particulars of these and other courses in the prospectus to be obtained from the Principal.

GEORGE E. HILLEARY,
Town Clerk.
16th, August, 1926. 3179

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PUBLIC NOTICES

The Institution of Structural Engineers.
MODIFIED EXAMINATION FOR ASSOCIATE-MEMBERSHIP.

A MODIFIED EXAMINATION for ASSOCIATE-MEMBERSHIP for candidates of and over 25 years of age who have at least 10 years' experience (including time served in apprenticeship or articles) in HELD QUARTERLY. It consists of an examination in Design worked privately by the candidate in the course of his practice at home. The NEXT EXAMINATION will take place on 18th SEPTEMBER (papers posted on the 17th), and entries must be in by 13th September. Syllabus and full particulars from the undersigned.

MAURICE G. KIDDY,
Secretary of the Institution.
10, Upper Belgrave-street, S.W. 1. 3135

Egyptian Government.

The Irrigation Department of the Ministry of Public Works is calling for :—

(a) The SUPPLY and ERECTION of STEEL and IRONWORK for Lock, Regulator, Swing Bridge and subsidiary works ;

(b) The CONSTRUCTION of MASONRY of a LOCK, REGULATOR and SUBSIDIARY WORKS, all at Kafr Butin, in Egypt.

Tenders are due in Alexandria, Egypt, up to Noon, 1st November, 1926.

Tender forms, specifications, drawings, &c., may be obtained on payment of 12s. 6d. for the steel work (a), &c., and Two Guineas for the masonry (b), &c. (which charges are not returnable), from the CHIEF INSPECTING ENGINEER, Egyptian Government, 41, Tothill-street, Westminster, S.W. 1. 3401

The South Indian Railway Company, Limited.

The Directors are prepared to receive TENDERS for the SUPPLY of :—

1. SOLID-DRAWN STEEL BOILER TUBES.
2. CARRIAGE FITTINGS.
3. FIVE BOGIE PETROL TANK WAGONS.
4. STRUCTURAL STEEL WORK (TENDER and BOILER SHOP).

Specifications and forms of Tender will be available at the Company's Offices, 91, Petty France, Westminster, S.W. 1.

Tenders, addressed to the Chairman and Directors of the South Indian Railway Company, Limited, marked "Tender for Solid-drawn Steel Boiler Tubes," or as the case may be, must be left with the undersigned not later than **Twelve Noon on Friday, the 10th September, 1926**, in respect of Specifications Nos. 1 and 2, and the 17th September, 1926, in respect of Specifications Nos. 3 and 4.

The Directors do not bind themselves to accept the lowest or any Tender.

A charge, which will not be returned, will be made of 5s. for each copy of Specification Nos. 1 and 2, 10s. for each copy of Specification No. 3, £1 for each copy of Specification No. 4.

Copies of the drawings may be obtained at the office of Messrs. Robert White and Partners, Consulting Engineers to the Company, 3, Victoria-street, S.W. 1.

W. B. REYNOLDS,
For Managing Director.
25th August, 1926.
91, Petty France, S.W. 1. 3426

SITUATIONS OPEN

COPIES OF TESTIMONIALS, NOT ORIGINALS, UNLESS SPECIFICALLY REQUESTED.

WANTED, MAN with Sound Mechanical Engineering experience, for an important Gravel and Sand Co., to carry out repairs and additions to Crushing and Washing Plant, Excavating Cranes, &c. Salary £250-£300 per year.—Address, stating age, experience, and enclose references, P2193, The Engineer Office. P2193 A

A YOUNG ENGINEER WANTED, with £100 to £250 capital, to Take Charge of Silver-lead Mining Plant (Ireland). Liberal partnership interest.—Address, P2204, The Engineer Office. P2204 A

A YOUNG SALES ENGINEER REQUIRED by a Firm of Lift Makers capable of preparing Electric Lift Tenders and carrying out general technical and sales correspondence. Preference given to applicant having previous lift experience. State fullest particulars and salary required in confidence.—Address, 3416, The Engineer Office. 3416 A

ASSISTANT MANAGER WANTED by Marine Engineers, Dry Dock Owners and Ship Repairers in China. Aged about 35.—Address, detailing experience and qualifications for this position, P2206, The Engineer Office. P2206 A

CONSTRUCTIONAL ENGINEER REQUIRED for 3-month approx. contract, West of England. Applicants should be experienced in Steel Erection, Rigging, Placing Concrete, and be able to control direct labour.—Address, giving full particulars, P2200, The Engineer Office. P2200 A

CONTRACTOR'S AGENT REQUIRED for Large New Road Contract in South of England. Must be thoroughly experienced in Excavation and Reinforced Concrete Road Construction. State age, experience, salary required, and when free.—Address, 3414, The Engineer Office. 3414 A

ENGINEERS (TWO), Not Over Thirty-five, University education, successful record in industrial work, especially production costs. Must have personally handled labour for at least four years. Liberal salary.—Apply, SIR FRANCIS PRICE, Hensol, Pontyclun, Glamorgan. 3188 A

REQUIRED for Important Anglo-Argentine Railway, ASSISTANT QUANTITY SURVEYORS, age about 30 and capable of taking off according to London practice. Preference given to fully qualified men with some years' experience with reputable quantity surveyors. Salary £600 per annum ; free passage provided.—Write, stating age, if single or married, education, training, experience and copies (only) of testimonials, to Box P. M., c/o Davies and Co., 95, Bishopsgate, E.C. 2. 3418 A

WANTED, a Real Good DRAUGHTSMAN, One used to Instrument Work preferred, with knowledge of General Engineering. Must be quick, neat, and energetic. Excellent prospects and permanency to the right man. Only those possessing above qualifications will be considered. Salary according to ability.—Address, 3194, The Engineer Office. 3194 A

WANTED AT ONCE, a First-class JUNIOR ELECTRICAL DRAUGHTSMAN, used to Switchboard and Instrument Work. Must be quick, neat, and not afraid of work. Good prospects and permanency to the right man. Only those having first-class experience need apply. Salary according to qualifications.—Address, 3193, The Engineer Office. 3193 A

WANTED AT ONCE, Young DRAUGHTSMAN, experience in Hydraulic Machinery essential.—Apply, giving full particulars, to HENRY BERRY and CO., Ltd., Croydon Works, Leeds. 3402 A

WANTED IMMEDIATELY, First-class DRAUGHTSMAN for Commercial Vehicle Work in North of England, capable of making lay-outs and some design.—Address, stating experience, age, and salary required, 3411, The Engineer Office. 3411 A

A VACANCY Occurs with a Provincial Lift Firm for a DRAUGHTSMAN ESTIMATOR. Prior consideration will be given to one having previous similar experience on Electric Lift Work and accustomed to the preparation of drawings and estimates for tenders. Neatness, accuracy, and quickness essential. State in confidence full details of past experience and commencing salary required in first instance.—Address, 3415, The Engineer Office. 3415 A

DRAUGHTSMAN, Junior, for London Office. Knowledge of Structural Steel Work Design essential. State age, experience, and salary required.—Address, 3197, The Engineer Office. 3197 A

SITUATIONS OPEN (continued)

DRAUGHTSMEN.—FIRST-CLASS CIVIL ENGINEERING DRAUGHTSMEN REQUIRED TEMPORARILY in Railway Engineer's Office in London ; must be thoroughly experienced in all kinds of Structural Work and able to work with a minimum of supervision.—Address, stating age, experience, and salary required, 3147, The Engineer Office. 3147 A

DRAUGHTSMAN for Structural Engineers' Office, London ; must be expert designer of Light Structural Work and prepared to travel London area. State experience, which firms, age, and salary required.—Address, P2189, The Engineer Office. P2189 A

DRAUGHTSMAN, Senior, WANTED, with First-class experience in the lay-out and design of Coal and Ore Conveying and Handling Plants. Must be capable of taking complete charge of contracts throughout.—Write, stating full details of experience, age, and salary required, to FRASER and CHALMERS ENGINEERING WORKS, Erith, Kent. 3410 A

DRAUGHTSMAN WANTED by Engineering Firm for Jig and Tool Work for catalogue purposes. Must be a thoroughly practical man.—Address, P2187, The Engineer Office. P2187 A

DRAUGHTSMAN WANTED, with Up-to-date Experience in Boring and Turning Mill Design.—Apply, stating age, wage and full particulars of experience, to WEBSTER and BENNETT, Ltd., Northey-road, Coventry. 3141 A

EXPERIENCED LEADING LOCOMOTIVE DRAUGHTSMAN for works in Lancashire.—Address in confidence, stating age, experience, and salary required, 3419, The Engineer Office. 3419 A

FIRST-CLASS DRAUGHTSMEN REQUIRED, Used to design and detailing of all classes of Constructional Steel Work. State age, experience, and salary required.—Address, 3421, The Engineer Office. 3421 A

GOOD DETAILING DRAUGHTSMAN WANTED for London office. One thoroughly conversant with Steel-framed Building Work.—Address, stating age and experience and salary expected, also when free for engagement, P2198, The Engineer Office. P2198 A

STRUCTURAL DRAUGHTSMEN REQUIRED, by North-East Coast ; well up in Design and Detailing ; only men experienced in this class of work need apply. State salary required.—Address, 3148, The Engineer Office. 3148 A

WANTED for India, a First-class FOREMAN MOULDER for Steel Foundry, making a large variety of Steel Castings, chiefly for railway rolling stock. Applicants must have had experience in mass production from pneumatic and hand moulding machines and be able to design their own plate patterns, &c., from engineers' drawings. A knowledge of sands and the manufacture of moulders' composition, core sands, &c., is essential. Good organiser and one tactful in handling labour. Salary Rs. 600 per month, with house allowance of Rs. 100 per month. Three years' agreement, with second-class passage out and home. Single man preferred.—Address, giving full particulars of past experience and present employment, to No. 2552, "Courier," Dundee. 3422 A

BOILER SHOP FOREMAN REQUIRED for General Boiler Shop in East Midlands ; will be required to undertake some Marking-off.—Address, giving age, salary and experience, 3162, The Engineer Office. 3162 A

ENGINEER FOREMAN WANTED by Ship Repairers in China ; experienced in all types of Diesel Marine Engines ; also with practical Steam Experience ; Chief Engineer's Certificate essential. Aged about 35. Reply fully, with copies of testimonials.—Address, P2205, The Engineer Office. P2205 A

REQUIRED in London Office, Ambitious YOUNG MAN ; Shorthand, Typist, Bookkeeping ; excellent chance of progressive position. State engineering experience, age and salary.—Address, P2167, The Engineer Office. P2167 A

SITUATIONS WANTED

A.M.I.C.E. (35), Railway Loco. Works, D.O. and running sheds, also general mechanical engineering and public works experience, shortly finishing contract, DESIRES progressive POSITION where initiative and a varied experience are needed. Used to control of large staffs and not afraid of responsibility.—Address, P2197, The Engineer Office. P2197 B

ENGINEER, A.M.I. Mech. E., G.I.E.E., 20 Years' exp. works, drawing and commercial offices, incl. organisation and management and supervision of manufacture on Continent, SEEKS POSITION offering good return for results. Free at short notice. First-class credentials.—Address, P2196, The Engineer Office. P2196 B

ENGINEER REPRESENTATIVE.—The SERVICES (whole or part) of a highly trained MECHANICAL ENGINEER with up-to-date experience in the scientific application of Aluminium Alloys for weight and cost reduction are AVAILABLE.—Principals requiring high-grade assistance who can offer scope for such experience and a stimulating form of remuneration are invited to write, A. B., c/o Lile's Advtg. Offices, 4, Ludgate-circus, London, E.C. 4. 3184 B

ENGINEER (30, Single) DESIRES CHANGE, experienced in the DESIGN and ERECTION of PULVERISED FUEL PLANTS, Turbines and General Power Station Equipment, American and British practice. Two years assistant to shipyard works manager. Handle any class of labour, take charge of drawing-office, &c. Desires responsible position, home or abroad.—Address, P2195, The Engineer Office. P2195 B

ENGINEER MILLWRIGHT, with Considerable experience in factory maintenance, renewals and repairs, SEEKS RE-ENGAGEMENT as Works Engineer. Willing to give proof of abilities and invest £500.—Address, P2194, The Engineer Office. P2194 B

ENGINEER FITTER TURNER, with D.O. Experience, age 27, SEEKS POSITION, home or abroad.—A. TOMS, 26, Yorke-road, Croxley Gn., Herts. P2190 B

DRAUGHTSMAN and ENGINEER, London, 10 years shops, 16 years office, all-round experience, including patents and experimental work.—Address, P2202, The Engineer Office. P2202 B

DRAUGHTSMAN (London District) REQUIRES SITUATION ; 21 years' good all-round engineering experience.—Address, P2192, The Engineer Office. P2192 B

LADY (Young) REQUIRES SITUATION as TRACER. Full knowledge mechanical and architectural tracing, quick worker, neat, accurate, well educated. Low salary to start. What offers ?—Address, P2199, The Engineer Office. P2199 B

YOUNG MAN SEEKS POSITION as IMPROVER with Heating and Ventilating Firm ; served 4 years' apprenticeship, studying for A.M.I.H.V.E. exam. ; small premium for good position.—Address, P2201, The Engineer Office. P2201 B

YOUTH (17) SEEKS POSITION as Junior Draughtsman ; over 2 years' technical training, automobile or building trade preferred.—Address, P2188, The Engineer Office. P2188 B

PARTNERSHIPS

IF YOU ARE SEEKING
A PARTNER or PARTNERSHIP
or wish to buy or sell a
BUSINESS or WORKS
Write :
WHEATLEY KIRK, PRICE & CO.,
46, Watling Street,
London, E.C. 4.
Established over 75 years.

A WELL-ESTABLISHED FIRM of GOVERNMENT CONTRACTORS, manufacturing superior grinding wheels and other abrasive tools, REQUIRES a further DIRECTOR. Only gentleman with connections in iron or steel foundries, engineering or motor car works, shipyards or other large consumers of the company's products will be considered. The gentleman ultimately chosen will be permitted to take a financial interest not exceeding £5000.—Enquiries should firstly be addressed to Box 257, Entrepreneurs, Ltd., 7, Queen-street, E.C. 4. 3187 C

COLLIERY OWNER SEEKS PARTNER with £500 capital to increase production of working mine already showing a handsome profit per ton.—Address, P2203, The Engineer Office. P2203 C

ENGINEERING.—An OPENING OCCURS to Take Active WORKING INTEREST in an established Engineering Firm. Amount required £1000. Balance sheets, &c., open to every investigation.—Address, 3198, The Engineer Office. 3198 C

MISCELLANEOUS

AMBITIOUS MEN Should APPLY at Once for FREE BOOKLET, giving full information regarding the A.M.I. Mech. E., A.M.I.E.E., A.M.I.A.E. and all other Technical Examinations.

Tuition guaranteed until successful ; lowest fees. Courses in all engineering subjects leading up to the A.M. Tech. I. qualification.

Write at once, stating branch of Engineering in which you want to specialise, to—
THE TECHNOLOGICAL INSTITUTE,
76, Thanet House,
P2140 I 231, Strand, W.C. 2.

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For continuation of For Sale Advertisements see page 3.

A Seven-Day Journal

The Coal Dispute.

As was widely anticipated would be the case, the meeting held on Thursday of last week between the representatives of the Mining Association and those of the Miners' Federation very speedily came to a complete deadlock. The meeting lasted only for about two hours and broke up without a single step being taken to bring the coal dispute to an end. The men's representatives expressed a determination to continue opposition to any extension of the hours of work and to any agreement other than a national one, and to consent to discuss the question of wages only after possible measures for the reorganisation of the industry had been considered. They argued that an extension of hours was not necessary for the successful operation of the mining industry, and that a national agreement for the settlement and regulation of wages was essential to the best interests of the industry as a whole. Further Government assistance was hinted at as desirable, but the owners' representatives made it clear that they remained strongly opposed to a subsidy. The meeting could find no real basis for negotiations, and ended without any attempt being made by either side to arrange for another at a later date. The breakdown of the meeting set free the mine owners and miners in certain districts to consider suggested local schemes for the resumption of work, and in the Midland districts especially large numbers of men began at once to manifest a desire to return. Each day that has passed since the London meeting broke up has witnessed an increasing number of men descending the pits.

The National Fuel and Power Committee.

DURING the past week the Board of Trade announced the appointment of a National Fuel and Power Committee in accordance with the recommendations of the Royal Commission on the Coal Industry. This Committee is to consider and advise upon questions connected with the economic use of fuels and their conversion into energy, having regard to national and industrial requirements and in the light of technical developments. The Committee, under the chairmanship of Sir Alfred Mond, will consist of Mr. J. Baker, Mr. M. Brand, Sir John Cadman, Sir Arthur Duckham, Sir William Hart, Mr. Frank Hodges, Professor F. A. Lindemann, Sir D. R. Llewellyn, Mr. M. Mannaberg, Mr. C. H. Merz, Sir A. Walker, and Mr. D. M. Watson. It will, or should be, thoroughly representative of most interests connected with the fuel industry. Mr. Baker and Mr. Hodges represent the trades unions on respectively the iron and steel and the colliery sides. Mr. Brand and Sir David Llewellyn represent the coalowners, and Mr. Mannaberg stands for the iron and steel manufacturers. Mr. Watson is governor of a large gas company and Sir John Cadman is technical adviser to one of the principal oil companies. Sir Arthur Duckham and Mr. Merz will be able to speak on many of the engineering aspects of the situation; while Professor Lindemann, of Oxford, will deal with the physical science side. Sir William Hart, town clerk of Sheffield, and Sir Alexander Walker, a Scottish whiskey distiller, will no doubt be in a position to advance the views of the consumer.

Sir Alfred Mond's Views on the Coal Situation.

THE South African diamond industry has for a considerable number of years successfully practised a scheme of regulated output, and following its example, a similar scheme is now being discussed to control the output of the Union's new platinum industry. In Sir Alfred Mond's opinion regulated output is also desirable in the British coal mining industry. Sir Alfred's views on the coal situation, expressed in a public interview last Saturday on the eve of his departure for Canada, are interesting, although as chairman of the newly appointed Fuel Economy Committee a certain amount of reticence at this stage might fittingly have been exercised. He believes that at present this country's normal output of coal represents an over-production of 15 per cent. and that this fact has led to the prevailing uneconomic situation. Unless production is regulated to suit consumption we may, he argues, expect a continuation of alternate periods of boom and slump from which the coal industry has suffered for a long period and which are bad not only for that industry, but also for all others. Our aim, he says, should be to control production and sales in order to stabilise prices and avoid unnecessary expenditure of capital. To make coal mining an industry and not a gamble he recommends that attention should be concentrated on production in the most economic unit at full-time rate rather than in a number of uneconomic units at part-time rates and that selling should be regulated in such a way as to ensure to the consumer consistent quality and stable prices. Above all, peace for a number of years is, he holds, essential in the industry, for without peace the coalowners cannot hope to obtain the co-operation of capital for the purpose of effecting such reorganisation as is necessary. Dealing with the work before the Fuel Economy Committee, he remarked in the course of the interview that it would undoubtedly cover a wide field and would, he anticipated, include consideration of the most economical use of all forms of fuel in industry and possibly for domestic purposes, improvement in existing practice in the utilisation of steam, the relative advantages of electrification and many other important and interesting subjects.

Steel Tires and Road Damage.

MANY complaints have been made by highway authorities and others to the Ministry of Transport regarding the damage done to road surfaces by steel-tired traction engines and wagons, particularly by those vehicles the wheels of which are fitted with "strakes." The complaints originate in all parts of the country and are particularly frequent during the early summer months, just after the road surfaces have been dressed. In the aggregate the damage done in this way to the roads amounts to many thousands of pounds. Some highway authorities themselves own steel-tired vehicles and might well follow the example of an important county council, which has recently decided to discard its whole fleet of this type of vehicle. Other bodies, such as the Showmen's Guild and the Traction Engine Owners' Association, have agreed to urge their members to use rubber tires or pads on all their tractors, traction engines and trailers other than those intended purely for agricultural purposes. Not only does this course reduce the damage done to the roads, but it has been found that it results in easier running and reduced cost of maintenance. In a letter circularised by the Ministry of Transport during the last few days to all highway authorities in Great Britain it is suggested that these bodies should do their utmost to discourage the use of steel-tired vehicles on the roads which they maintain. Two methods of effecting such discouragement are indicated, namely, the fitting of rubber tires to all steel-tired vehicles at present owned by the authorities themselves and specifying that all engines and vehicles used under haulage contracts shall be equipped with rubber tires or pads.

New Ships for the Navy.

THERE is, we understand, a good prospect that the battleship Nelson will be commissioned before the close of the current financial year. She is now being fitted out at Armstrong, Whitworth and Co.'s yard on the Tyne, where she was launched on September 3rd, 1925, and barring unforeseen delay, she should be ready for trials during the coming winter. The sister ship Rodney, which went afloat at Birkenhead three months later, may not be ready for sea until the late spring or summer. Owing to their novel design and the fact that they are the first battleships to be constructed under Washington Treaty rules, the completion of these ships will be an event of outstanding importance in the naval world. Of the total cost of each ship, estimated at £7,000,000, the hull accounts for 20 per cent., armour for 30 per cent., gun-mountings for 30 per cent., guns for 12 per cent., and machinery for 8 per cent. The construction of the two vessels and their equipment has provided employment for an average of 21,000 persons since December, 1922. None of the new cruisers will be completed before the next financial year, though five are already afloat. Four more are on the stocks and three additional ships are to be laid down this year. Including the two Australian units being built at Clydebank, fourteen new cruisers are under construction or about to be laid down. All save one are of the 10,000-ton "County" class, the exception being an 8000-ton "Class B" ship of this year's programme. The new destroyers Amazon and Ambuscade are understood to have reached the trial stage.

A Noteworthy Ship Repair.

WITH the recent docking of the Clan Liner Clan Macnaughton, at the Elderslie dry dock of Barclay, Curle and Co., Ltd., Glasgow, a ship repair job of more than usual interest was brought to light. Early in February last the Clan Macnaughton, while on her outward voyage, ran aground off the Tasmanian coast, and sustained serious hull damage. She was eventually refloated, when it was found that the heel of her stern frame had been completely carried away, whilst several starboard plates were buckled and the aftermost keel plate pierced. The ship was towed to Melbourne for dry docking and examination, but the members of the Australian ship repairers trade unions refused to touch the ship unless the owners would agree to full permanent repairs being carried out. Eventually the members of the engineering staff of the ship decided to do the job themselves. It was not without some difficulty, we are informed, that local material, such as girders, plates, bars, rivets, bolts, &c., was secured. All the fitting, drilling, and riveting was done by the ship's own engineers. A stout girder was attached to the broken part of the stern frame at the keel plate, and was carried out horizontally to join two vertical girders, which were fixed to the remaining upright part of the stern frame. The rectangular frame thus formed was further stiffened at the corners by side plates. When it was surveyed, the repair was found to be so strong that the vessel was allowed to proceed home under her full power. Other hull damage was repaired by cement patches, which held throughout the homeward journey. It is of interest to know that the new lower part of the stern frame which was sent out by the owners to be used in case of emergency was not required, and was brought home in the ship. The job we have referred to was carried out in the face of much difficulty, and its successful completion bears tribute to the resource and ability of the chief engineer of the Clan Macnaughton and his staff.

Wreck Statistics for 1925.

THE returns recently published by Lloyd's Register of Shipping giving a summary of all ships over 100 tons totally lost, broken up, condemned or otherwise removed from effective service, show that for the year 1925 the gross reduction in the mercantile marine of the world amounted to 739 ships, representing an aggregate of 1,142,035 gross tons. Out of this total 553 steamers and motor ships accounted for 980,794 tons, and the remainder, 186 sailing ships, totalled 161,241 tons. Comparing these figures with the similar returns for the year 1924, a decrease of 633,868 tons as regards steamers and motor ships, and 81,776 tons for sailing ships is shown, or a total decrease for 1925 of 715,644 tons. This reduction is not entirely due to fewer actual casualties, for although for steamers and motor ships there is a reduction in casualties of 136,070 tons, only 579,574 tons of this class of ship were broken up during 1925, compared with 1,326,134 tons in 1924. The tonnage of ships owned in Great Britain and Ireland which was broken up, dismantled, &c., during 1925, amounted to 203,107 tons. In relation to the total tonnage owned in Great Britain and Ireland the average percentage loss of steamers and motor ships was only 0·32 per cent. The statistical tables which accompany Lloyd's statement, show that strandings and kindred casualties, which are usually grouped under the heading "wrecked," are the chief cause of disaster, and account for about 50·7 per cent. of the steamer and motor ship losses, and 46 per cent. of the sailing ship losses. Abandonment, foundering, reported missing, &c., account for 28 per cent. of the losses for the two classes of vessels. The number of vessels broken up, condemned, &c., during 1925 amounted to no less than 74 per cent. of the total number of steamers and motor ships, and 58 per cent. of the total number of sailing ships, included in the tables referred to.

Motor Shipbuilding in Italy.

THERE seems to be little doubt that for some time to come Italy will take an important share in the development of the motor propelled ship. It will be recalled that Lloyd's Shipping returns for the half year ended on June 30th last showed Italy as the second motor shipbuilding country of the world. The first place was held by Great Britain and Ireland, with a gross tonnage of 293,544 of motor ships under construction, and fifty-two marine oil engines, with an aggregate of 278,209 indicated horse-power. Italy was second with motor vessels of 215,183 gross tons, and twenty-four marine oil engines totalling 119,300 indicated horse-power. Recent news from Italy states that the Florio Soc. Italiana di Navigazione à Vapore is to order fourteen motor liners of 5400 tons for its daily express service between Naples and Palermo, and ten 3000-ton motor vessels for its other services. It is understood that these ships will be built in part at Riva Trigoso, partly at Palermo, and partly at Ancona. The firms mentioned in connection with this large order are the Cantieri Navali Riuniti, the Cantieri Navali del Tirreno and the Taranto yard of the Franco Tosi Company. Recent orders for motor vessels which have been received by the Stabilimento Tecnico Triestino include two 12,000-ton liners for the Egyptian service of the Lloyd Triestino Company, and two 3000-ton passenger ships for the Adria Steamship Company's service between Fiume and Spain. Two 2500-ton motor ships are to be built for the Nautica Soc. di Navigazione à Vapore by the Cantieri Navali del Carnaro at Fiume.

Amalgamation of German Electrical Firms.

IT is rumoured that the three leading German electrical firms, the A.E.G., Siemens Halske, and the Bergmann Company are about to amalgamate. The three firms practically monopolise the home market, and also play a very important *rôle* in the international markets, being behind many subsidiary companies in various European and overseas countries. Competition among themselves has already been mitigated by agreements concerning several branches of industrial activity, and they have participated in the constitution of the Osram Company, which is associated with the International Electric Bulb combine. The A.E.G. and the Siemens Company are also already co-operating in the wireless business, and are exchanging the results of their experience in other directions—as, for instance, in railway electrification and telephone construction. It is also generally known that the Siemens Company owns a fairly important holding in the Bergmann Company, which holding, according to reports, has recently been increased. The advantages to be derived from an amalgamation of the three concerns are pretty obvious.

New Electrical Equipment at Southampton Docks.

No. II.*

Automatic Control Gear.

As we explained in the first article, the controlling equipment for the de-watering pumping plant in No. 6 Station is of the push-button-operated automatic type. As a matter of fact, all the pumping plants in the docks are controlled in the same manner, with the exception of (*a*) the high-pressure turbine pumps used for hydraulic power purposes, which will

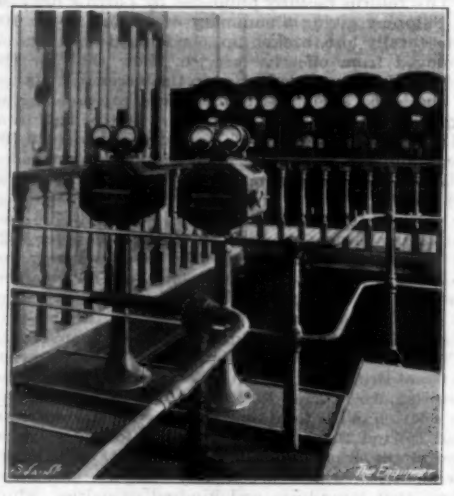


FIG. 9—OPERATING PILLARS FOR 950 H.P. MOTORS

be described later and which are automatically operated from accumulator tappet switches, and (*b*) the small units controlling the drainage, priming and house pumps, which are hand operated.

The chief interest in the automatic equipment naturally centres round the controllers for the large de-watering and impounding pumps, which, as has already been explained, are driven by 1200 brake horse-power asynchronous-synchronous motors that are operated directly from the 6600-volt supply. Other motors of 950 horse-power and 350 horse-power capacity are employed for driving pumps in other parts of the installation, but since all the controllers for the asynchronous-synchronous motors are identical—with the exception of the number of steps and the size of the contactors—we will describe the operation of the 1200 horse-power equipment only. These 1200 horse-power motors are the largest of their type at work in this country; indeed, we believe that they are the largest asynchronous-synchronous motors in the world operating on a 6600-volt supply and controlled automatically.

* No. I. appeared August 20th.

The automatic controller comprises two triple-pole high-tension air-break contactors, with charging resistances for the stator circuit, a panel carrying the various contactors and relays for the rotor and exciter circuits, and an operating pillar with the regulator and instruments for the exciter. This operating pillar also carries the "start," "stop" push buttons.

The group of four triple-pole high-tension contactors which is illustrated in Fig. 15, page 224, are operating in connection with two of the large asynchronous-synchronous motors installed in No. 5 Station. The contactors are arranged on a platform underneath a gallery. The charging resistances can be seen above each pair of resistances. They are mounted on porcelain insulators suspended from the girder work above the contactors. Each high-tension contactor is carried separately on a strong angle iron frame, and the complete assembly is enclosed by a screen of expanded metal. The access doors are interlocked with the main oil switches, which must be opened before entry can be made to the high-tension contactor enclosures, so as to ensure complete safety in the event of adjustments being necessary to this part of the equipment. Each contactor is operated by means of two standard low-tension alternating-current magnets, one of which is mounted at each end of the shaft that carries the three moving contacts. This shaft is of steel covered with mica and is provided with a stage of porcelain insulation at each end, so that it is completely insulated from the framework, and each phase also is efficiently insulated. The stationary contacts are mounted on specially insulated heavy mica-covered steel bars. Both the moving and the stationary contacts have a rolling action and are also fitted with large arcing horns. There is a powerful double magnetic blow-out on each phase, and are shields with renewable linings are also fitted.

The charging resistances, one bank of which is used in conjunction with each pair of triple-pole high-tension contactors can be seen mounted above the contactors in Fig. 15. They are of the metallic type, being wound on mica-insulated steel tubes and mounted on porcelain insulators. The connections throughout are of the mechanical type, no solder being used in the construction of these resistances.

The contactor panel and resistance for the 1200 horse-power asynchronous-synchronous motor is illustrated in Fig. 16, page 224. This panel contains the low-tension contactors and relays, which are mounted on specially-treated slate slabs, and enclosed in a sheet steel case, with hinged inspection doors, which were removed temporarily to make the view clearer. This illustration shows the time elements at the right of the top left-hand door opening and the various relays, some of which can be seen on the right-hand side of the panel. All the contactors are operated by standard low-tension alternating-current magnets, and where necessary they are provided with magnetic blow-outs. The alternating-current magnets are of the laminated single-phase type, and are fitted with special silencing windings embodied in the laminations of the stationary portion, in order to secure quiet operation. A special transformer—single-phase—is employed for supplying current to open all the coils.

The levers carrying the moving contacts are mounted on substantial square shafts, carried in plain bearings of large dimensions. The contactors are directly operated by the magnets, no links or toggle mechanism being employed. The contacts have a rolling action and the copper tips are renewable. The main resistances, which are of the metallic unbreakable rustless pattern, are mounted alongside the rotor panels, and are enclosed.

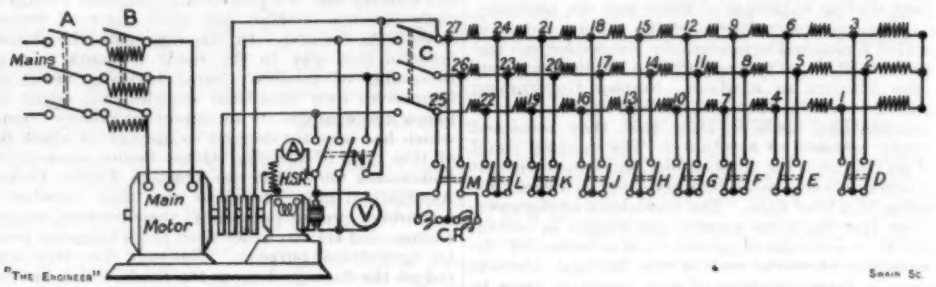


FIG. 10—DIAGRAM OF CONNECTIONS FOR OPERATING ASYNCHRONOUS-SYNCHRONOUS MOTORS

The automatic timing element which controls the closing of the various contactors is simple in design, and is provided with means of adjustment for varying the period between the closing of each individual contact, as well as for increasing or reducing the total time of operation of all the contactors. It comprises a number of discs connected to a moving spindle, there being one disc for each contactor. Each disc makes contact with a pair of steel studs, which are provided with renewable copper contact pieces. In addition to this time element, current-accelerating relays are used at certain points in the cycle of operations, so as to ensure the correct action of the controller.

Two of the operating pillars are seen in Fig. 9. They carry the "Start," "Stop" push buttons for each equipment, as well as the shunt regulator and instruments for the exciter. In addition to the push button included in the operating pillars, a pair of push bottons is also installed close to the machine so that the equipment can be started or stopped either from the operating point where the pillars are installed, or from the floor of the pump house.

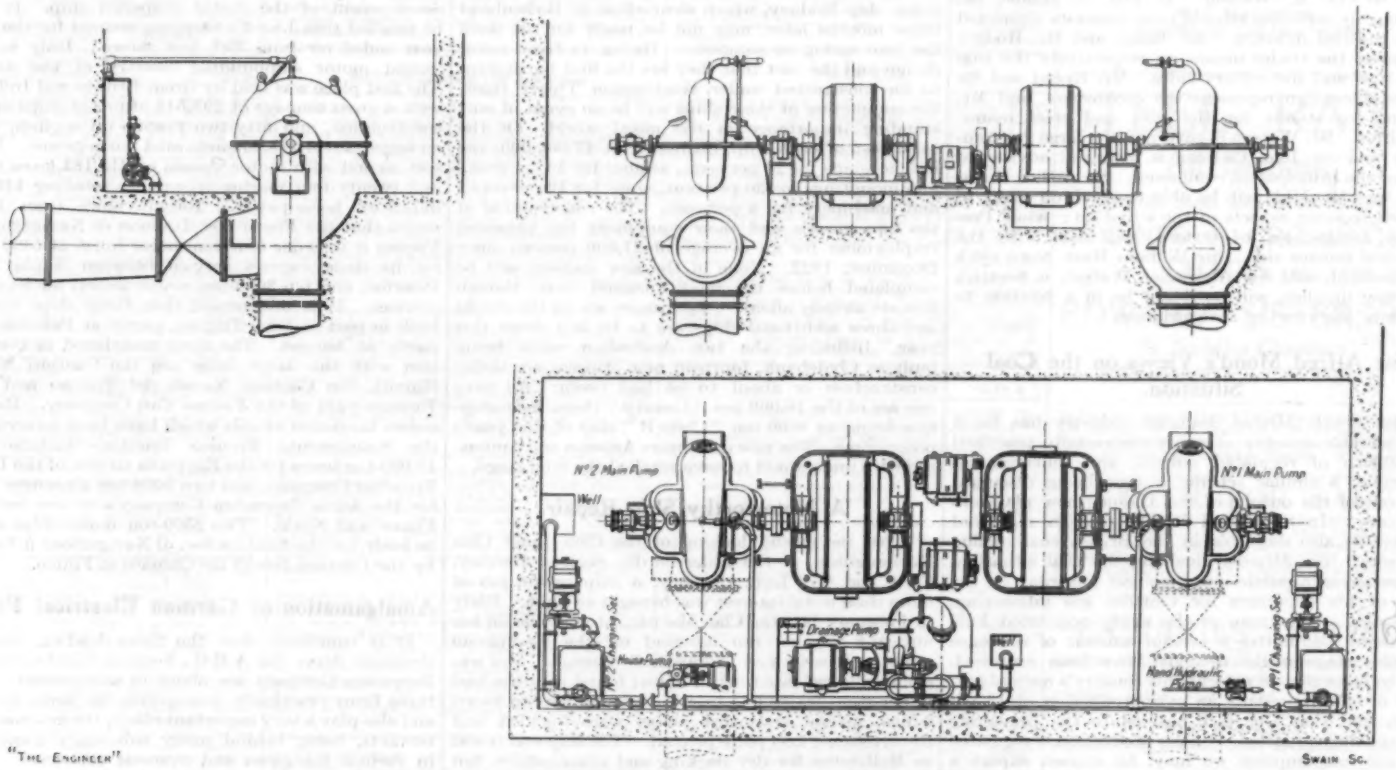


FIG. 11—ARRANGEMENT OF NO. 5 PUMPING STATION

The starting operation of one of these asynchronous-synchronous motors can be followed by reference to the schematic diagram, Fig. 10. When the requisite "Start" push button is pressed, the high-tension contactor A closes the stator circuit through the charging resistance, which is designed to limit the switch-on voltage to approximately 50 per cent. of the line voltage. After a pre-determined time interval, the second high-tension contactor B closes, short circuiting the charging resistance, thus applying full voltage and full magnetising current to the stator of the motor. The buffer-resistance contactor D closes next, thus allowing sufficient current to pass to start the motor, after which the accelerating contactors E to M close successively under the control of the master controllers. The final contactor M is provided with a current relay, which at the correct moment, disconnects the rotor entirely from the motor by opening contactor C. The synchronising contactor N then closes automatically under the control of a relay which connects the exciter to the slip rings at the right moment, thus causing the motor to pull into step and run as a synchronous machine. The controller is provided with the necessary relays, to ensure correct sequence of operations, from the moment the "Start" button is pressed until the machine is running at normal full speed. To stop the equipment it is only necessary to press the "Stop" button, when the contactors open in the correct order and the machine is brought to rest. The control circuit for the various contactors is fed from a single-phase oil-immersed transformer stepping down from 6600 to 220 volts. Separate from the controller there is the usual main triple-pole oil-immersed hand-operated circuit breaker, provided with automatic releases for protection against overloads.

It will be noted that the scheme of operation for the controller is designed essentially to protect the motor during the starting and stopping periods. The combination of the charging resistance in the stator circuit with the buffer resistance in the rotor circuit is introduced to eliminate the possibility of high-voltage surges building up at the end windings of the motor during the switching operations. This, the makers claim, is a very important feature of the equipment, and we understand that it has operated most successfully since the plant was first installed.

In addition to these large asynchronous-synchronous motors, there is a number of other smaller alternating-current motors of the slip-ring induction type. As will be seen, too, the installation also includes a number of pumps driven from a 480/500-volt direct-current supply. One of the 1200 horse-power dewatering pumps is driven by a direct-current motor, which is also controlled by means of push buttons with an automatic type controller. Different types of control gear and accessories are shown in Figs. 17, 18, 19, and 20 on page 224. Figs. 17 and 19 are views of the contactor controllers for the 1200 horse-power direct-current motor, the glazed doors having been removed when the photograph was taken for the sake of clearness. The hand wheel for the shunt regulator and the "Start" and "Stop" push button box will be observed on the right-hand side of the casing in Fig. 17. Fig. 18 shows contactor controllers for a 175 horse-power and a 12½ horse-power direct-current motor for driving pumps in connection with the hydraulic installation to be referred to later. The main isolating switch, the automatic time element, the contactors and the overload relays are all clearly seen. The large panel operates from tappets on the accumulators and the small panel from float switches operating in an open tank. Fig. 20 represents an automatic controller for one of the drainage pumps In this case also the cover has been removed for the sake of clearness. The complete installation includes sixteen alternating-current controllers, totalling 4258 horse-power, and eight direct-current controllers, totalling 1348 horse-power, or, in all, twenty-four controllers, amounting to 5606 horse-power.

The installation provides an interesting example of the ease and facility with which large electrically driven power units can be started and stopped by the simple operation of pressing a button, and the importance of the installation is striking testimony of the reliability of modern automatic control gear.

The whole of the automatic control gear, both for alternating-current and direct-current supplies, is of the "Empire" contactor type designed and manufactured by Electric Control, Ltd., of Glasgow.

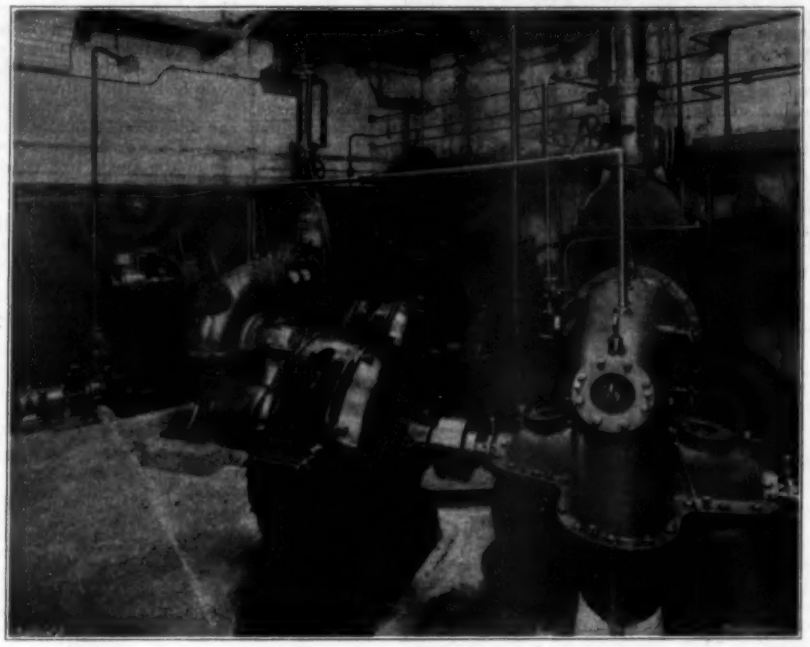


FIG. 12—INTERIOR OF NO. 4 PUMPING STATION

The 60,000-ton Floating Dock.

As has been already said, the large floating dock, the position of which can be seen at the top of the drawing on page 189 *ante*, is operated by electrical energy obtained from the sub-station which is housed in Pumping Station No. 6. It will be convenient, therefore, to refer to its electrical arrangements here before passing on to describe the de-watering equipment of the other docks.

We have in the past referred on several occasions to the dock and the pumps for operating it, notably in our issues of October 20th, 1922, and February 22nd, 1924, and it will not be necessary, in the present instance, to go into any great detail regarding either. We may say, however, that the de-watering plant comprises fourteen pumps, ten of 18in. diameter and four of 15in. diameter, designed to deliver 8220 and 6350 gallons of water per minute respectively against a mean head of 29ft. The pumps were made by Worthington-Simpsons and they are driven by Crompton motors. The pumps, which are submerged in the dock bottom, are each connected by a vertical spindle to its motor. The motors, which are of the variable-speed type, are of 113 brake horse-power capacity for the larger pumps and of 85 brake horse-power for the smaller. They are arranged along the tops of the dock walls, and they—as are also various valves needed for the sinking and raising operations—are controlled by push-button gear, which is operated from a centrally placed control cabin. The motor control is of the ordinary contactor automatic type and the valves are operated on the Westinghouse electro-pneumatic control system. In addition to the main pumping plant, there are eight electrically driven shores for centring the ships between the dock walls, fire and wash-down pumps, capstans, air compressors and pumps for supplying circulating water for the condensers of ships while in the dock. There are also two electric travelling portal cranes, one on each wall, each crane being capable of lifting 5 tons at a radius of 48ft. or 2 tons at a maximum radius of 80ft.

Altogether the power required to operate the dock at full load is some 1200 kilowatts or more. Energy is received from the sub-station in Pumping Station No. 6 in the form of direct current at 480–500 volts on a three-wire system, so that 480 volts is available for the larger motors and 240 volts for lighting and other services. The current is taken on board through three lead-covered paper-insulated cables per pole, each cable having a cross-sectional area of 1 square inch. These cables are carried under one of the mooring beams and up the dock wall to a main switchboard, which is erected in a cabin on the top of the starboard wall, that is, the wall which faces towards the sub-station. The problem of leading the cables over the swivel joints of the booms, at which points considerable up-and-down and side motion takes place, presented considerable difficulty. It was finally decided to employ joint boxes, fixed on both sides of the universal joints, and to bridge the gaps by means of flexible cab-tire-covered cables. The difficulty of doing the work satisfactorily was increased by the fact that the boom is completely immersed in water when the dock is submerged, and cables and boxes are thus subjected to very severe changes of temperature and surroundings. However, all troubles were satisfactorily overcome and everything is working well. The cables and the boxes through which the cables are led into the dock were manufactured by the Pirelli General Cable Works, Ltd., of Southampton, which is one of the associated factories of the General Electric Company, Ltd.

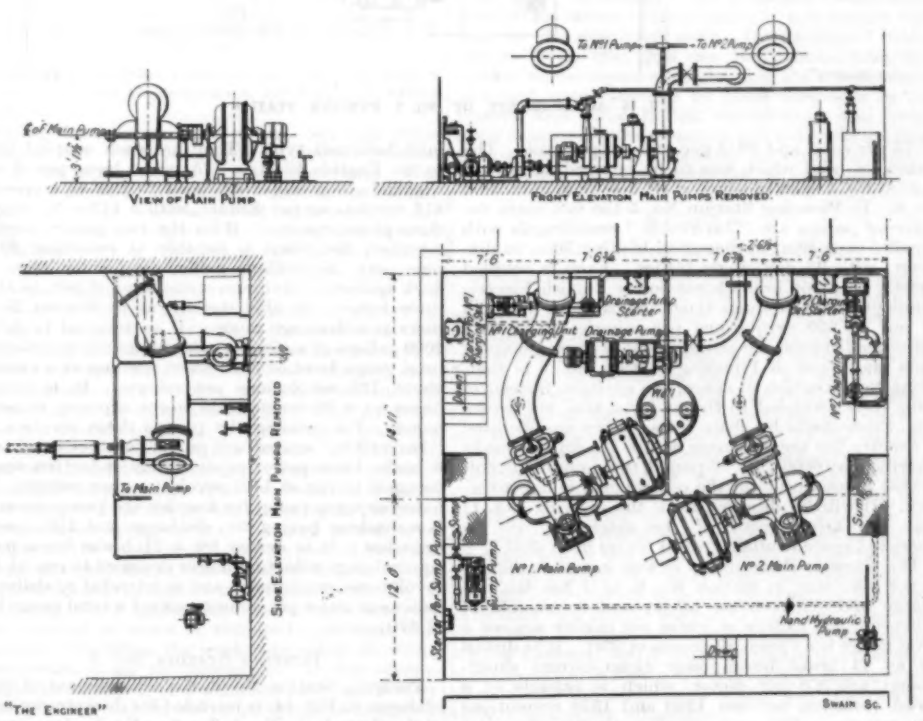


FIG. 13—ARRANGEMENT OF NO. 4 PUMPING STATION

Pumping Station No. 5.

The next largest graving dock after the Trafalgar is that known as the Prince of Wales Dock, which lies to the south of the Empress Wet Dock. It is 745ft. long, has an entrance 91ft. wide and its water content at H.W.O.S.T. is 75,000 tons. It was originally operated by two steam-driven 48in. centrifugal de-watering pumps, and a 12in. centrifugal draining pump. As there was not a sufficient supply of direct

current at this south end of the docks it became necessary to install motors of the asynchronous-synchronous type. It was also decided to put in rotary converters to increase the available direct-current supply. These machines are of 250 kilovolt-ampère capacity. Since all the machines only differ from corresponding machines in Sub-station No. 6 in the matter of size, it will not be necessary to describe them in detail. The de-watering machinery with which this pumping station is now equipped and which is contained in No. 5 Pumping Station—see Fig. 11—is identical, except as regards power, with the machinery in Pumping Station No. 6, already described. The reason for less powerful machinery being installed is that, though the dock has a capacity of only three-quarters that of the Trafalgar Dock, the period within which the specification called for it to be pumped out—four hours—was the same. Furthermore, as the inlets and outlets were the same in both docks, *i.e.*, 48in., a lower water velocity could be employed in the case of the smaller dock, and that made itself felt in the efficiency of the pump, the efficiency of the smaller machine being actually higher than that of the larger. The guaranteed combined efficiency of the pump and motor was, with the larger machine, 69·5 per cent., and with the smaller 72 per cent., the guaranteed efficiencies of the two motors being

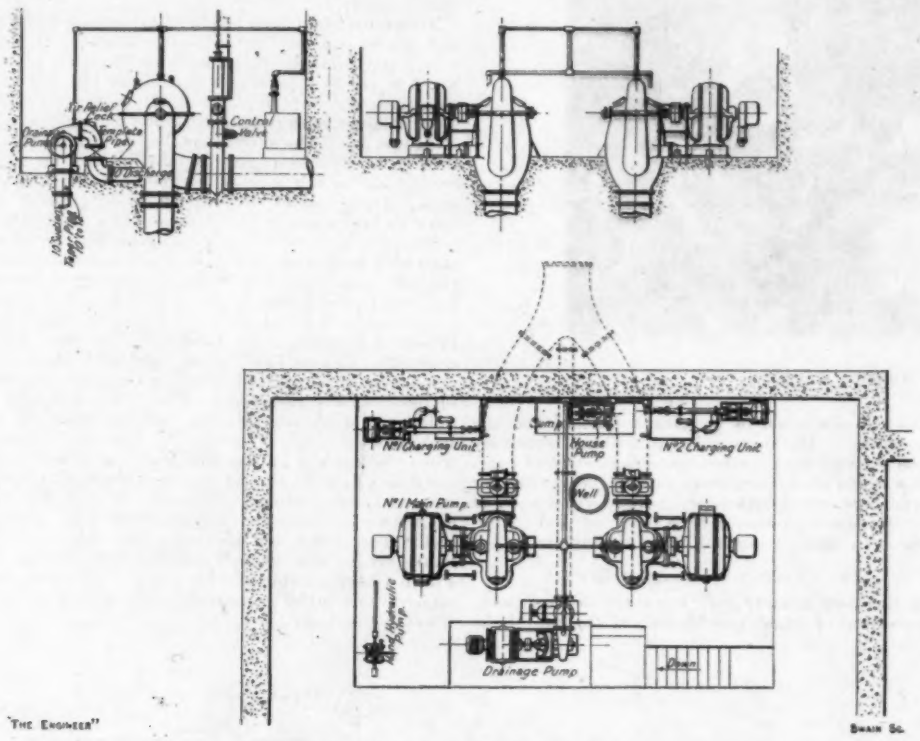


FIG. 14—ARRANGEMENT OF NO. 3 PUMPING STATION

92·75 per cent. and 92·3 per cent. respectively The maximum head which was to be pumped against in Station No. 5 is 36ft., which is 1ft. less than in Station No. 6. In Pumping Station No. 5 the two main de-watering pumps are "Invincible" centrifugals with impeller eyes 39in. in diameter, blading 50in. in diameter, with 35 deg. angle blades. Each is coupled directly to a 950 brake horse-power English Electric Company's asynchronous-synchronous motor designed to run at 250 revolutions per minute. The only difference between the arrangement of these pumping units and those in Pumping Station No. 6 is that, owing to restriction of space, the exciters, instead of being direct coupled to the motor shafts, are driven from those shafts by chain belts. They are operated in exactly the same manner as are the units already described, by 6600-volt, 50-period, three-phase current, so that a description of the control gear is not necessary. It will be observed from the drawing Fig. 11 that the arrangement of the machinery in the restricted space available called for no little skill.

The house or sump pump in this station is slightly larger than that in Station No. 6, as it has 4in. discharge and 5in. suction inlets, and is capable of delivering 500 gallons of water per minute against a total gauge head from all causes ot 35ft. It is driven by an 11 brake horse-power direct-current shunt-wound 480/500-volt motor, which is capable of a speed variation between 1250 and 1350 revolutions per minute. The two priming plants aro exact duplicates of those in Station No. 6.

The original drainage pump in this station was steam driven. It has been replaced by an electrically driven machine designed to pass up to 3000 gallons of water per minute against a total gauge head from all causes of 50ft., and is a single-stage "Invincible" centrifugal, having 12in. discharge and 14in. suction branches. It is driven through a flexible coupling by a 70 brake horse-power shunt-wound English Electric Company's 480/500 direct-current motor, which is capable of a speed variation between 650 and 800 revolutions per minute. There is in this station also one of the main pressure pumps for the hydraulic services throughout the docks, which we shall describe later, as well as a small hand-worked hydraulic pump for use in operating the sluice valves should the main hydraulic supply fail.

PUMPING STATION NO. 4.

Pumping Station No. 4, which is used for emptying either No. 4 or No. 3 dry dock, and a view inside which is given in Fig. 12, is another case calling for ingenuity in the arrangement of the machines, as will be seen from Fig. 13. The pumps which it houses are similar in character to those in Pumping Station No. 5, excepting in size; that is to say, there are two de-watering units, a drainage pump, two charging units, a sump or house pump, and a hand-worked hydraulic pump for operating the sluices. The pumps, it will be observed, are set with their shafts at an angle with the centre line of the pump-room. They have two 18in. suctions, and they had to be specially designed, because they have replaced two steam-driven pumps of a very early type which had twin suctions, one on either side of the impellers. In this case, as in Pumping Stations 5 and 6, the pumps had to be made to connect up with the pre-existing suction and delivery pipes. The pumps are Gwynne "Invincibles," having cast iron impellers, 26in. diameter, and of the double-inlet balanced type. They are each coupled direct to an English Electric 175 brake horse-power slip-ring induction motor designed to run at a speed of 416 revolutions per minute, with a 415-volt, 50-cycle three-phase current. With the two pumps working together, the plant is capable of removing 20,000 tons—say, 4½ million gallons—of water from the dock against a maximum static head of 26ft. in about three hours. In this station, as in Station No. 5, there is a drainage pump. It is designed to deliver 2000 gallons of water per minute against an estimated total gauge head of 37ft. when running at a speed of about 725 revolutions per minute. It is coupled direct to a 36 brake horse-power slip-ring induction motor. For priming the pumps there are two 3in. "Invincible" centrifugal pumps, each coupled to an 8 brake horse-power squirrel-cage induction motor, designed to run at 1405 revolutions per minute. The house or sump pump for keeping the pump-room dry is a machine having 2in. discharge and 2½in. suction branches. It is driven by a 2½ brake horse-power squirrel-cage induction motor designed to run at 1410 revolutions per minute, and is intended to deliver 80 gallons of water per minute against a total gauge head of 37ft.

PUMPING STATION NO. 3.

Pumping Station No. 3, the arrangement of which is shown in Fig. 14, is intended for de-watering either of the three docks No. 1, No. 2 or No. 3. Its pumping machinery equipment is identical with that in Pumping Station No. 4, saving that, instead of the main pumps having two 18in. suctions, they each have 24in. suction and delivery branches. They are each coupled directly to a 175 brake horse-power slip-ring induction motor designed to give its output at 416 revolutions per minute on a 415-volt, 50-cycle, three-phase supply. These two pumps working together at full speed are designed to deliver 28,000 tons of sea water from the dock in about 3½ hours, commencing at or about H.W.O.S.T. against static heads increasing from zero to a maximum of 37ft. Since the remainder of the plant is a duplicate of that in Station No. 4, we need not refer to it in detail. In both these stations the main sluice valves, which are hydraulically operated at a pressure of 750 lb. per square inch, and a good deal of piping had to be supplied, in addition to the machinery.

We should have liked to embody in this account some particulars of the results obtained during the official trials of all these pumping plants. That, however, is impracticable. The fact is that the tests had to be conducted as and when there was an opportunity, and without interfering with the normal working of the docks, and a good many difficulties had to be overcome. Hence, the figures obtained are not in a form suitable for publication. It can be said, however, (*a*) that in all cases the pumping capacities contracted for were considerably exceeded, and (*b*) that with the variable heads the pumps showed perfect self-regulating characteristics; that is to say, that, throughout the de-watering operations, though the head and volume of water discharged were continually varying, while the speed was constant, the power consumed also remained sensibly constant and the motors were in no case overloaded.

Although, however, we are unable to give the official test figures, we give below a copy of the contractors' guarantee figures which, as we have said, were all more than met:—

Contractors' Guarantees.

	Motor at full load.		Combined unit.	
	Efficiency.	Power factor of motor.	Max. efficiency.	B.H.P.
	Per cent.		Per cent.	
No. 6 pumping station:				
Constant-speed de-watering pump ..	92·75	0·9 (leading)	69·5	1120
Variable-speed de-watering pump ..	93·5	D.C.	70·0	1120
Impounding pump ..	90·0	0·9 (leading)	63·0	265
House pump	79·7	D.C.	42·3	6·2
No. 5 pumping station:				
Main de-water'g pumps	92·3	0·9 (leading)	72·0	820
Draining pump	91·3	D.C.	67·5	61·2
House pump	82·9	D.C.	46·3	9·75
Nos. 3 and 4 pumping stations:				
Main de-watering pumps	90·6	0·84	67·0	160
Drainage pump	88·0	0·86	63·7	32
House pump	76·0	0·82	27·0	2·1

British Association.

No. IV.*

WE complete below our account of the meeting at Oxford of the British Association, which terminated on the 11th inst.

SECTION A.

X-RAY CRYSTAL ANALYSIS.

Professor W. L. Bragg described some quantitative methods of X-ray crystal analysis. He said that it was generally assumed that waves in the X-ray region scattered by the atoms of a crystal obeyed the laws of interference which had proved capable of explaining diffraction in optical experiments. It had been found that this assumption was justified. Evidence was accumulating that not only were the classical laws of interference obeyed, but that the amount of energy scattered by the electrons was given by the well-known electro-magnetic equations. Crystal analysis assumed quite a new aspect when precautions were taken to obtain reliable measurements of intensity of diffraction. The distribution of electron density throughout the crystal and surrounding the atoms could be deduced from the results which had been obtained, and structures of a complex type could be analysed. Experimenters were now within measurable distance of reaching the position at which the structure of a crystalline body could be deduced directly from the X-ray data. It had to be recognised, however, that in using the classical laws to explain X-ray diffraction, experimenters were confronted with the incompatability of these laws with the quantum laws for the interchange of energy between waves and matter. That did not necessarily invalidate the conclusion as to the distribution of electrons in the atoms drawn from the X-ray data. In many cases, however, the classical laws gave the right solution, but there was strong evidence that their fundamental interpretation required to be modified.

Dr. J. E. Lennard-Jones discussed the nature of the forces between ions and a crystal. He pointed out that the first step towards the correlation of the physical properties of crystals lay in the determination of the forces between the constituent atoms and ions, and in some recent researches it had been shown that the forces between certain ions in crystals could be correlated with the forces between the inert gas atoms. Theoretical calculations had been made of the inter-atomic distances of a large number of crystals which were in satisfactory agreement with the observed

* No. III. appeared August 20th.

values. The coefficient of compressibility and electricity had also been calculated, and had been found to be in fair agreement with the observed values where they had been ascertained. The information which had been obtained concerning ionic and atomic forces had been applied to other problems of crystal structure which had defied solution hitherto. It had been possible, for example, to gain some knowledge of the reason why certain crystals, including Cs Cl, set as body-centred cubics and other crystals, among them Na Cl, set as face-centred cubics.

SECTION G.

Pressure in Impulse Steam Turbines.

The distribution of pressure in a multi-stage turbine at varying loads and under varying conditions of operation is a matter of considerable importance, particularly in mixed pressure and heat-extraction turbines.

Mr. W. J. Kearton, who presented a paper on the subject, said that, in general practice, the pressure distribution in multi-stage turbines was arranged by a suitable adjustment of the nozzle areas, so as to bring the ratio of blade velocity to steam velocity at exit from the nozzles in all stages as near to the optimum value as economic conditions would permit when the turbine was operating at its economical load. The value of this ratio, as was well known, ranged from about 0·24 for two-row velocity compounded impulse turbines to 0·94 for reaction turbines. In some designs the mean diameters of the various blade rings were all made equal, and it followed that, for the same type of blading, the heat drop would be the same for each stage in such cases. In other designs, especially when high-pressure steam was used and an attempt was made to realise a high efficiency, the blade rings were made relatively small in the high-pressure stages of the turbine, so as to reduce disc friction losses, the disc diameters being progressively increased towards the low-pressure end. In such turbines the heat drops were quite small at the high-pressure end and increased towards the exhaust end, varying actually as the square of the mean diameters.

When the conditions of operation differed from the "economical load" conditions, the steam weight passing through the turbine might be slightly increased, or, on the other hand, very much reduced and, as a result, the nozzle areas would then be incorrect. Usually the weight of steam flowing through the turbine per second was diminished. That caused a decrease in the steam velocity at exit from the nozzles in certain stages and had several results. One was to change the ratio of blade velocity to steam velocity, causing a reduction of blade efficiency; another was to change not only the relative velocity at the direction of the steam flow into the blades which might involve serious losses, and a third effect was that the exit area of the blades would in general be too large, which might result in an indeterminate loss due to imperfect direction of the steam jet.

His main object, the author said, was to outline a method whereby the pressure and heat drop distribution in a steam turbine might be predicted for operating conditions differing from the designed conditions, and to show the practical application of this method. The pressure distribution in a nozzle was largely a function of the cross-sectional area at different points along the nozzle axis, and might be determined readily. In a turbine, however, the velocity of the steam was a discontinuous function. The method he had evolved made use of :—(*a*) A curve showing the actual total energy available by expansion from the initial to any given pressure; (*b*) a curve showing the approximate specific volume of the steam at any pressure; and (*c*) the equation of continuity. The calculation was by a step-by-step process beginning at the exhaust pressure, and gave reasonably accurate results without refinement or extreme care in calculation.

The paper, said the author, illustrated the application of this method to the high-pressure impulse turbine with nozzle-control governing in the first stage, to the mixed-pressure turbine, and to heat-extraction turbines. In the first named type the larger changes in heat drop occurred at the low pressure end of the turbine, there being a slight and fairly uniform reduction in heat drop per stage in those stages more remote from the exhaust outlet. In steam turbines governed by simple throttling there was an appreciable reduction of heat drop at light loads, owing, of course, to the throttling which occurred at the governor valve. As such free expansion losses also occurred in turbines of the mixed-pressure and heat-extraction types, in which the working conditions varied so very widely, some coefficient to allow for this reduction would be of value to engineers and designers. With regard to the mixed-pressure turbine, one feature which affected the distribution of heat drop under variable operating conditions was that the nozzles in the low-pressure stages must be large enough to pass the whole of the low-pressure steam, and were thus about twice as large in area as they need be for operation with high-pressure steam alone. The result was that when the turbine was operating on high-pressure steam the heat drop in the last two stages of the machine was appreciably diminished. A further result was that the steam pressure in the first low-pressure stage of the turbine at full load was only 9·25 lb. per square inch absolute, so that in the event of a small quantity of low-pressure steam being admitted to the turbine, it would be wire-drawn from about 20 lb. absolute to 9·25 per square inch absolute. At partial loads the amount of wire-drawing, and hence the throttling loss, would be greater still. The heat extraction turbine was being adopted to an increasing extent in industries in which a large amount of steam was used for heating purposes and a certain amount of power was required. The power might indeed become a saleable by-product. The conditions of operation of that type of turbine were very varied, but if any form of nozzle-cut-out governing were adopted in the high-pressure first stage, the efficiency of the high-pressure stages would be fairly well maintained. A matter of considerable interest and importance to plant engineers was the position of the extraction turbine compared with that of its rival the heat extraction engine. The latter possessed several advantages, there being no loss due to throttling in the low-pressure cylinder either at light or full loads. The question of choice was, however, affected by other considerations, including size of plant, initial cost, space occupied, and cleanliness of heating steam. Except for relatively small powers, most of these considerations weighed in favour of the turbine.

Torsional Stresses.

Professor F. C. Lea presented a paper by himself and Mr. H. P. Budgen dealing with the effect of a constant torsional stress upon specimens subjected to repeated bending stresses.

The paper was largely descriptive of a machine designed by the authors, and gave results of tests carried out under the following conditions :—(1) When the specimen was loaded as a rotating beam in such a way that a test length of 3in. was subjected to constant bending moment; (2) when a constant twisting moment was transmitted through the specimen. The results of the tests were of interest as throwing some light on the problem of the conditions of failure under repeated stresses. The experiments showed that an addition of a constant shearing stress to a bending stress, provided it was below a certain value, did not lower the number of repetitions to which a material could be subjected under cycles of bending stress. Taking results as a whole, however, the data obtained did not solve the vexed question how and why a piece of material failed under repeated stresses. It could be said that a constant shear stress below a value equal to the normal stress in one direction did not affect the life of the specimen, but when the constant shear stress exceeded the given value the normal stress range diminished rapidly. The problem was complicated by the fact that the maximum principal stress did not occur on the same plane as the maximum range. Analysis of the results indicated that sheer stress range was the important factor, and that the shear stress range was affected very considerably by the magnitude of the maximum shear stress applied by torsion.

Stress Concentration Produced by Fillets and Holes.

Mr. S. Timoshenko presented the section with a paper on "Stress Concentration Produced by Fillets and Holes."

In many cases, it was pointed out, very high stress concentrations were produced by holes, grooves, notches and sharp variation in cross-sections. This stress concentration was a very undesirable feature in materials which were subjected under service conditions to reversal of stress, and experience showed that the majority of fractures in service were caused by progressive cracks which started from points of high stress concentration.

It could be shown that the elementary theory of bending of curved bars gave an approximate solution for the stress distribution in the case of a plate with a circular hole with bead reinforcement. In the case of two dimensional problems, use had been made of transparent models with polarised light to get a picture of the distribution of stress. That method had been employed for the study of the stresses at the roots of gear teeth, and it had been found that with ordinary proportions the maximum stress was about 1·6 times higher than that shown by the usual beam formula. The root stress increased with decrease in radius of the fillet at the tooth root. In the case of reversal of stress the problem of concentration and its effects was investigated by means of fatigue tests. By a comparison of the loads necessary to cause fracture under reversal of stress of standard specimens and specimens with fillets, the weakening effect of stress concentration could be determined. It was shown, as might be expected, to depend not only on the fillet proportions but also on the property of the material. Experimental results in connection with copper showed that the weakening effect of stress concentration in ductile material could only be determined with accuracy if data were available of the fatigue tests of models of the particular machine part.

The B.E.S.A. Glossary.

Professor G. W. O. Howe read a paper which criticised the new glossary of the British Engineering Standards Committee, which deals with terms used in electrical engineering. He said that the objects aimed at in the preparation of the glossary were: (*a*) To standardise and co-ordinate the electro-technical terms used in the British Empire; (*b*) to provide a basis for the British portion of an international vocabulary, in course of preparation by the International Electrotechnical Commission. The glossary had been adopted by the International Electrotechnical Commission as a basis for the arrangement of an international glossary now in course of preparation by that body. Hence the need of pointing out the confusion of ideas which had arisen in connection with the definition of fundamental electrostatic terms. The definition of electrostatic flux and electrostatic flux density were examples of that, and similar defects were to be found in that section of the glossary which dealt with magnetic terms. The definition of electromotive force was quite fallacious. Other examples of what he termed "a hopeless muddle" were given by Professor Howe, who in conclusion said that he recognised the difficulties which confronted those who prepared the volume, having himself served on one of the panels; but, having regard to the claim made that the book was one which should be in the hands of every electrical engineer and student throughout the world, he felt compelled to make his protest. He would be sorry for any electrical engineer who sought enlightenment from the opening section of the glossary. His own opinion was that the volume should be withdrawn for purposes of thorough revision and hoped that in the national interest the British Engineering Standards Association would not hesitate to recall the work.

The criticisms raised by Professor Howe gave rise to a good deal of discussion, some of it in support of the statements made by the author of the paper and one or two other speakers taking an opposite view. At the close of the discussion it was stated by Sir John Snell that the questions raised were, as far as the electrical side was concerned, to be referred to a Committee of Section G, the formation of which had been approved by the Council of the Association.

Classification of Patent Specifications.

The uses which can be made of patent classifications by manufacturers are well known. They can ascertain what are their rights with regard to the manufacture of certain articles, or, if they are owners of the patent, the classification can be used to support the case for a monopoly and to challenge infringement.

Dr. A. P. Thurston described the systems which had been adopted and the detailed methods which had found approval in different countries. He claimed that the work done by the British Patent Office was a superb achievement. It had been in daily operation for over twenty years, and had enabled searches to be made with precision and accuracy. In the existing classification every specification was indexed for all matters of interest, whether claimed or not, and appeared in the indexes under all relevant sub-headings. That was not the practice followed in the United States or in Germany. There were no "see also" references. The published classification and the allotment of cases under it was exactly that used by the examining staff. In the United States Patent Office that was not the method adopted; instead repeat copies were placed in the official search files and were classified by cross references in the printed key. The British classification was based upon construction or structure, and not upon application, although it bore marks of its evolution from a classification based on industries or application.

SECTION L.

Science and the Humanities.

Professor C. H. Desch addressed the Education Section on the history of science as a link between science and the humanities. He claimed that, for the ordinary student of science, instruction in the history of the subject was best given, not in separate classes, but as part of the normal course. By relating each important discovery, as it was dealt with, to the state of thought at the time, the importance of science in human history could be made clear. In the teaching of applied science, the connection between great discoveries and inventions and social and economic conditions afforded many themes for the teacher, and provided a means of directing the attention of the student to social studies, which were so apt to be neglected by the science specialist. On the other hand, the student of history and literature might be brought into contact with the facts and conceptions of science by a similar method of approach. The link could only be completed by the recognition of sociology as a science, and it could be maintained that that was the only true means of bridging that gulf between science and the humanities which was too characteristic of modern education.

Education by Wireless.

Mr. J. C. Stobart, in a paper to this Section, described what was being done to utilise broadcasting for educational purposes. Steps had been taken, he said, to form in each centre, where a broadcasting station had been established, educational advisory committees, and more recently one of H.M. Inspectors of Schools had been appointed as Director of Education. It could now be claimed that the experimental stage of the work had been satisfactorily concluded, and the need of the moment was for better organisation of reception of the service, and that listeners

should follow up wireless instruction with systematic reading courses. Co-operation with universities had been secured at all stations. Technical difficulties had tended to restrict the scope of educational broadcasting, but with the institution of an alternative wave-length system it should be possible to make considerable further progress as the present need of reconciling entertainment with instruction in one programme would be obviated. The next step should be the formation of listening classes, possibly in connection with the rural libraries scheme, and negotiations to bring that about were already in train. Education authorities were recognising more and more the assistance which could be rendered by wireless lessons in solving the problems of rural education, and, though financial stringency was still a serious obstacle, the number of pioneer schools was steadily increasing. It was thought that official adoption could not be long delayed.

Conversazione.

The conversazione, which was held in the University Museum on the evening of August 10th, was largely attended, and an interesting series of lectures as well as exhibits had been arranged in the various departments.

In the electrical laboratory the principal exhibit was that of Hadfields, Ltd. It included some of the original specimens of manganese steel, the first transformer in which the silicon steel of the firm was employed, and exhibits to show the sequence of developments in the production of non-corrodible steel. To illustrate the practical uses of the last named steel the exhibits included the rotor of an exhaust gas turbine installation, in which the material is required to withstand temperatures of from 800 deg. to 900 deg. Cent., and working speeds of 30,000 revolutions per minute. The exhibits of the Research Department of the Hadfield Works comprised some specimens of ancient iron and steel and the now familiar temperature charts. The Cambridge Scientific Instrument Company showed ray track apparatus, and a special form of galvanometer. The former, in conjunction with Mr. R. W. Hardisty and Messrs. Gill and Donaldson, sent for inspection an apparatus for electrolodeless discharge at low pressure, with a frequency of 50 million per second; stationary waves on solenoids, and the Holweck pump; and an apparatus showing the Cady effect. The Eötvös torsion balance was shown by L. Oertling, Ltd.,; Mosley's original apparatus and diagram by Mr. S. P. McCallum; and some short wave generators, the result of work in the laboratory at Oxford, were exhibited by Mr. J. H. Morrell.

Demonstrations of the growth of crystals were given in the Main Court Museum, by Dr. T. V. Barker and Mr. R. C. Spiller. A demonstration of weather forecasting, which proved very popular, was given by the Meteorological Department of the Air Ministry; and cinema films, with synchronised sounds, were shown in the Clarendon Laboratory, where Sir William Bragg gave a film lecture. Other lectures were on "The Time Factor in Explosions," by Sir Robert Robertson, and "New Experiments on the Combustion of Carbonic Oxide," by Professor W. A. Bone. It was a well-organised and successful entertainment.

Visits.

The programme of visits and excursions included an inspection of the locomotive and wagon shops of the Great Western Railway at Swindon; a display by the Royal Air Force and an exhibition of some of the new types of machines, and apparatus used on aircraft; and a visit to the famous Bodleian Library, where an opportunity was given of inspecting manuscripts and printed books dealing with general science, mathematics, chemistry, cartography, astronomy and medicine.

Perhaps the most interesting of all the places thrown open to inspection, and Oxford is, of course, rich in things of general and special interest, was the Lewis Evans collection of scientific instruments, which is now installed in the Old Ashmolean Building, erected in 1679–83 as a central institution of scientific studies.

The collection, which was described before the Education Section, by Dr. R. T. Gunther, is rich in mathematical apparatus of an early date, but it is now possible to examine side by side with these examples of ancient instruments a valuable series illustrating the educational methods of the principal periods of European science. Starting with astrolabes made by the Moors in Spain in the eleventh and twelfth centuries, there are instruments used by members of the Merton School of the fourteenth century, one of which, the rectangulus of Richard of Wallingford, has just been reconstructed. The navigational instruments of the Elizabethan period are well represented by the great astrolabe of Humphrey Cole, which, however, is not a part of the Oxford Collection, but was, with other instruments, lent by the University of St. Andrews for the meeting of the British Association. The scientific inventions of the founders of the Royal Society of Oxford are unfortunately only represented by a few models and reconstructions of works by Boyle, Hook, Wren and Mayow, but the period immediately following is admirably illustrated by the unique collection lent by Christ Church, and the nature of the scientific teaching a century later, 1790–1820, is shown by the cabinet of physical apparatus lent by Oriel College, and by some old chemical glass from the University laboratory in the Old Ashmolean Building. This, which contains what is believed to be the oldest collection of chemical glass in the world, illustrates educational methods from the time of Lavoisier to that of Sir Humphrey Davy. Its preservation is due to one of the founders of the British Association, Dr. Charles Daubeny, and his successors of Magdalen College.

The Levels of the Great Lakes of North America.

By WILLIAM PORTHOUSE, F.R.A.S.

For several years Canada has been immersed in a flood of controversy regarding the levels of the Great Lakes of North America. Water abstracted from the Lakes system is utilised by the riparian authorities in Canada and the United States for sanitary and industrial purposes, and naturally every effort is expected of both nations to maintain the normal levels of the respective lakes. Of recent years, however, there has been a steady fall in the surface levels of all the lakes except Superior. That this is a serious matter for Canada can be realised when one considers the immense amount of capital invested in lake-side districts in the way of waterworks undertakings and hydro-electric and sewage-disposal plants. All of these establishments must necessarily have been designed to operate on a surface level with a minimum range of fluctuation, and any serious change of level, such as that which is now causing trouble, would render all such plants more or less inefficient if not actually useless.

Apart from this serious aspect of the question and its reaction upon conditions of existence on the lake shores, what might be called the grotesque aspect has been pointed out by a vivid writer in one of the Toronto newspapers:—

> "Boathouses are perched far inland like henhouses. Channels that used to lead right to cottage wharves are dry land, and wharves are set like tent platforms on eminences of their own. Cottages that used to be upon islands are on the mainland now. Water pumps suck air. The whole summer civilisation has been rendered ridiculous. The steamers cannot call at certain ports. . . . Merritton's fire-fighting system is impotent. Others can no longer use their water-pumping installation in case of fire. Bays into which sewage was dumped are so shallow as to be no longer fit to receive the sewage." (Gregory Clark, in the Toronto *Star*.)

There is no gainsaying the serious position in Canada as revealed by the words I have quoted, and it is not surprising that feeling has recently become intensified, and is finding vent in the Dominion Legislature. As late as April, 1926, a joint resolution moved by the party leaders was passed unanimously by the Canadian Parliament, condemning what is facetiously known in the Dominion as the "great water steal" by Chicago, and calling for diplomatic action against alleged un-neighbourly legislation which is proposed by the United States. Canada is unanimous in blaming Chicago for the present lowering of the lakes level. Whether Canada is wholly right or wrong I shall try to determine presently. The matter was the subject of an earlier discussion in the Canadian Parliament in March, when the Minister of the Interior—Mr. Stewart—is reported to have used these words:—

> "We do not recognise the diversion of water by Chicago. We want the restoration of the whole of the water which has been diverted illegally from the Great Lakes. We are not so much concerned with compensation for damage done. We want the water and nothing else."

On the same occasion the leader of the opposition, Mr. Meighen, could not imagine what argument the United States could advance in defence of Chicago's diversion of water from Lake Michigan. Following this discussion a resolution was adopted embodying an appeal to England to take up the question of Treaty rights with the Government of the United States.

The view embodied in these Parliamentary discussions is, of course, that of the Canadian extremist, and allowances have to be made accordingly. At the same time, the sincerity of the feeling which has inspired that view is not in question now; there is no doubt that Canada believes herself to be genuinely aggrieved, particularly against Chicago, and to be to some extent fighting for existence against a cunning and outnumbering enemy of outward friendliness. What follows here is intended to show that that belief is not as well founded as the proceedings in the Canadian Parliament would lead one to imagine, and that there is really little excuse for the impassioned appeals to the United States to "make war on Chicago," which one has found recently in the Canadian newspaper headings. The cause of the reduced levels must be sought in other directions.

The diversion of water from the Great Lakes system is governed by the Boundary Water Treaty of 1910 between the United States and Great Britain, and knowledge of the terms of the Treaty is essential as a preliminary to a proper understanding of the problem which is now disturbing the Dominion. Article V. permits the diversion at Niagara for power purposes of a maximum of 20,000 cubic feet per second—c.f.s.—by the United States, and a maximum of 36,000 c.f.s. by Canada. Article VIII. prescribes the order of precedence among the various uses of boundary waters, viz.:—"First, uses for domestic and sanitary purposes; second, uses for navigation, including the service of canals for the purpose of navigation; third, uses for power and for irrigation purposes."

Constant withdrawal from any body of water will naturally result in a lowering of the surface level unless the loss is made good by inflow. Abnormal climatic conditions in the Lakes watershed during the past few years have reduced the amount of inflow, whilst the run-off has been maintained if not actually increased. The effect has been to lower the level of the Lakes to such an extent that many interests are being prejudiced. Cargo boats on the Lakes are said now to be working on three-quarter load, and the lake-side towns in the United States and Canada are becoming increasingly apprehensive respecting the future of the power supplies which they draw so cheaply from the Niagara River. Moreover—and this should be a matter of interest to the whole world—the Falls of Niagara are losing their picturesqueness, owing *inter alia* to the lessened depth of water passing over the crest. Indeed, the less optimistic spirits believe—let us hope, unjustifiably—that sooner or later the American Falls will be completely unwatered, and that the erosion of the Canadian—Horse-shoe—Falls will increase to such an extent that the present nuisance from obscuring mist and spray will develop finally into complete and permanent concealment of the remnant of one of the world's wonders.

Now, as a set-off against the Canadian view, I would present here the Chicago—not necessarily the American—case, written by a dispassionate Englishman, uninspired save by knowledge of the facts and long acquaintance with kindred problems.

The offender against whom the greatest feeling is expressed is the Sanitary District of Chicago, which is abstracting water from the southern end of Lake Michigan for sewage dilution purposes. For some reason or other—readily understood in some quarters, perhaps—a sewage authority is always an unpopular body, and that of Chicago is no exception. It is empowered by the United States Government to divert from Lake Michigan 4167 cubic feet of water per second. This volume is used to reverse the flow of the Chicago River into which the sewage of the city is discharged, and to cause that river to flow backwards into the Chicago main drainage canal, which carries the mixed sewage and lake water to the Des Plaines and Illinois Rivers, and ultimately by way of the Mississippi Valley to the Gulf of Mexico. No other sewage effluent has so long a journey before its final discharge into the ocean. The whole thing is an example of civil engineering on a heroic scale. The writer has in his possession an air photograph of Chicago. The confluence of the north and south branches of the Chicago River is seen taking place at a point about a mile from the Lake side. The water passing down the north branch of the Chicago River is black and filthy, while that coming in from the Lake is bright and clear. The photograph illustrates in striking and convincing fashion how the superior volume of clean water coming in from Lake Michigan overwhelms the polluted water from the north branch of the Chicago River, and dilutes and carries it to the main drainage canal by way of the reversed south branch. The writer, with thirty years' experience of sewage disposal and rivers conservancy work, maintains that no steps can be too difficult or costly if they will but exclude from the Lake from which the drinking water of three millions of people is taken that immense volume of foul and sewage-laden water which the photograph reveals.

Unfortunately for Chicago, however, its sewage authority has fallen foul of the United States Government, which, of course, has to bear in mind its responsibilities under the 1910 Treaty. It was found very soon that 4167 cubic feet per second was insufficient for the purpose of keeping the Chicago sewage out of the Lake, and the sanitary district applied for permission to divert 10,000 c.f.s. The United States Government, fearing increased damage to navigation interests, refused this permission, notwithstanding that its sympathies must obviously have been with Chicago. Thereupon Chicago took the law into its own hands, and proceeded to abstract more than 9000 c.f.s. An injunction was obtained, calling upon the offenders to revert to the smaller figure, but on appeal, the United States Secretary for War, as the final authority, issued official sanction to the abstraction of an annual average of 8500 c.f.s. This permit is to operate for five years only, and is accompanied by extremely stringent conditions regarding progress in the interim of constructional work on Chicago's programme of sewage disposal works. Even with the larger diversion, occasionally, when the Chicago River is in high flood, the incoming water from the Lake is overwhelmed, and the filthy river finds its way to the Lake, where it cannot help but foul the drinking water intakes.

So much for the necessity of the abstraction of water at Chicago. Sewage disposal by dilution is admittedly a lazy and wasteful method of treatment, but it should be noted that in this instance there is actually no economic waste of water. Besides serving the primary purpose of diluting the Chicago sewage, the water is used secondarily for the development of hydro-electric power. The power obtained is more

than sufficient for sewage disposal operations, and the surplus is sold for local municipal and industrial purposes. None of these operations involve actual loss of volume, and finally, the diverted water, by increasing the flow of the Des Plaines and Illinois Rivers, improves the sanitary and navigation conditions in those rivers and the canal system associated with them. It is difficult to imagine a more thorough and efficient and economic use of Lake Michigan's precious water before its energy is finally dissipated in the Gulf of Mexico. Its power is utilised virtually to the last ounce of the last gallon.

It is admitted on all hands that the total lowering of the Lakes is 2ft. to 3ft. as compared with the levels of thirty years ago. At Toronto, on Lake Ontario, one relative of the writer may no longer dive from the end of his boat landing, as he was once able to do; nor can another on the Georgian Bay now float his launch into the boat-house originally erected for it. Water is lacking at both places. Chicago admits that its diversion of water has lowered the level about 5in., but it will not admit responsibility for the extreme figures which are now causing the trouble. To contradict Chicago is to throw doubt upon its published statistics; to accuse it of acting *mala fide*. The stoutest Canadian critic can neither justify nor defend such a suggestion. Canadians appear to overlook the fact that the greater offenders are nearer home than Chicago. The Niagara power companies, in fact, divert more than 50,000 cubic feet per second or five times that of the Sanitary District of Chicago. It cannot be gainsaid, moreover, that more water is being abstracted on the Canadian than on the American side. The 1910 Treaty recognises and permits it.

The whole difficulty could undoubtedly be overcome economically and satisfactorily to everybody concerned if a more conciliatory and more enterprising spirit could be induced, and Chicago has taken the lead in an endeavour to clear up misunderstandings, calling for fair-mindedness and avoidance of exaggeration as factors necessary to permit the truth to prevail. The question is entirely an engineering one; of works, possibly massive in character but simple in operation, for maintaining and regulating the levels of the Great Lakes, similar to those which have operated successfully at the outlet of Lake Superior for many years. There is much to be said for the Chicago side of the question. "Domestic and sanitary purposes" taking precedence among the various uses of the water to be taken from the Great Lakes, the right of Chicago under the Treaty cannot be challenged, especially as the diversion of water commenced many years before 1910. Article II. of the Treaty specifically provides that diversions existing at the date thereof are to be excluded from its operation. On the wider question, Chicago maintains that there is no present economic loss to the country at large by using the Lakes water for power in Illinois instead of at Niagara. It is furthermore maintained that under present Treaty restrictions the water diverted at Chicago does not now and will not prevent the development of all the water power which it is possible to develop at Niagara by diversions now allowed by Treaty. The Chicago diversion reduces the flow of the Niagara and St. Lawrence Rivers about 5 per centum, and thereby the power that may ultimately be developed on those rivers. It is pointed out, however, that at Niagara Falls at present, under Treaty restrictions, only about one-quarter of the flow of the river is available for power, and not quite two-thirds of the power possible from such permissible water is at present produced. These are simple and telling facts, epitomising the Chicago case, which no Canadian authority has ventured to question or attempted to refute.

MAP OF THE GREAT LAKES OF NORTH AMERICA

Works of simple character proposed by the United States Army Engineers can be built, which would more evenly distribute the water passing over Niagara Falls, and Chicago has offered to contribute its share of the cost. Such works would save the Falls from the self-destruction now in progress, would restore and preserve their scenic beauty, and at the same time would render possible the use of more water for power production. They would also serve to equalise the Lake discharges, thereby increasing the present minimum outflows, which, in turn, would largely increase the prime or continuous power that could ultimately be developed in the Niagara and St. Lawrence Rivers, but such further power development at Niagara would necessitate a modification of the present Treaty. There are no Treaty restrictions as to the use of the St. Lawrence water for power purposes, but less than 10 per cent. of the available power is being utilised. The highest American civil engineering opinion is solidly behind the Chicago argument that there will be no economic loss of power on either the Niagara or the St. Lawrence Rivers by reason of the diversion of water from Lake Michigan until 95 per centum of the available power at each position shall have been developed.

Of the drainage area of the Great Lakes above St. Regis, where the international boundary line leaves the St. Lawrence, 50 per centum more is in the United States than in Canada. Lake Michigan contributes 50,000 cubic feet per second to the run-off of the Lakes. Having regard to the favourable terms enjoyed by Canada in respect of the Niagara power diversions, and to the relative areas of territory comprised in the Lakes themselves, Canada does not appear to have much to grumble about respecting Treaty rights and the relatively small diversion at Chicago. The minimum flow of the Niagara River draining the Great Lakes is 110,000 cubic feet per second, and the maximum 300,000 c.f.s. How futile it seems to saddle Chicago with the maximum responsibility when her maximum diversion is less than 10,000 cubic feet per second!

The Great Lakes rise and fall 3ft. to 5½ft. in irregular cycles of several years duration. The present low levels are due partly to natural variation in rainfall, evaporation, and ice conditions; and partly to diversions for the Chicago main drainage canal, the Welland Canal, the Black Rock Canal, the improved Erie Canal, and for water power at Niagara. Storage of water upstream on Lake Superior is also responsible to a small extent. These reasons can all be substantiated by official statistics of unquestioned reliability which need not be quoted here. Several of the Lakes have been substantially as low as at present on several occasions, sometimes lower. As these fluctuations are chiefly due to climatic causes, engineering opinion is unanimous upon the certainty of the old levels being soon restored naturally, even if not assisted by works of conservancy.

Chicago is not unmindful of its responsibilities, as is instanced by the valuable engineering documents which have been issued by the Sanitary District on various aspects of this unique problem. Twenty-eight of the greatest civil and sanitary engineers of the United States have been empanelled into a Board of Review to consider preventive and remedial measures. They are completely unanimous in their conclusions. The crux of the problem, of course, is that of sewage disposal, and the Sanitary District has rightly recognised that it is not sufficient to get rid of the offence by dilution. It is a matter of sewage treatment rather than sewage disposal, a distinction more important than subtle. The cause of the trouble must be tackled at the source, and the sewage rendered as safe as possible before its discharge into the Chicago River. To this end, vast schemes of sewage treatment by approved and up-to-date methods are now in progress. They include installations on the "activated sludge" process.

The estimated cost of the programme of sewage treatment works is 125,000,000 dollars, and working at the quickest rate economically and industrially possible, the plants will not be entirely completed until 1945. Even then, some diversion of Michigan water will still be necessary to maintain the Des Plaines and Illinois Rivers in a satisfactory condition.

The ultimate effect of these treatment works will be to improve the conditions in the Chicago River, and with an improved river there will be less necessity to call upon Lake Michigan for dilution water. For the time being, diversion of Lake water is vital to Chicago's existence as a self-respecting sanitary unit; the diversion of water for power purposes lower downstream, whilst desirable, is not vital, and, under Article VIII. of the Treaty, rightly takes last place in the order of precedence. Naturally, one has sympathy with the Canadian's desire to maintain an incredibly cheap hydro-electric power supply, but surely that cannot be insisted upon at the expense of the health of a monster city like Chicago with equal if not prior claims upon the boundary waters.

In conclusion, one cannot do better than quote Chicago's own summary of the position, viz.:—

> The Chicago Drainage Canal was authorised by the Illinois Legislature in 1889, and opened in 1900. It reversed the flow of the Chicago River, diverting Chicago's sewage from Lake Michigan; improved the city's only source of water supply; ended severe water-borne epidemics; provided one of the chief links in a waterway from the Great Lakes to the Gulf; led to a remarkable development of bathing beaches, and incidentally supplied power for public needs.
>
> The Chicago diversion has lowered the Great Lakes about 5in., while diversions elsewhere, improvements of outlet channels, and climatic conditions, have caused a lowering of 2ft. to 3ft. Reduced lake levels have damaged navigation and harbour works.
>
> Lake fluctuations can be largely eliminated, and the Lakes held near the highest desirable levels, by works constructed near their outlets. Such works are necessary regardless of the Chicago diversion, and their cost will be but slightly affected by it. They will protect all interests involved, increase low-water flow, greatly improve navigation and harbour conditions, allow more efficient use of water for power, and make possible the restoration and protection of the scenic beauty of the Niagara Falls.
>
> Diversion of water at Chicago is necessary for sewage disposal; it prevents gross pollution of the Lake; it improves navigation in the waterways from the Great Lakes down the Illinois and Mississippi Valleys; and it makes available hydro-electric energy in a region where needed. With lake and river regulation it will confer these benefits without damage to navigation in the Great Lakes and connecting waters; without affecting navigation conditions in the St. Lawrence River; and for years without reduction of power at Niagara and along the St. Lawrence River.

To abandon the Chicago drainage canal and discharge the sewage again into Lake Michigan, as is in effect demanded by the Canadian Minister of the Interior, is unthinkable. It would be a serious backward step in sanitation, which would virtually destroy Chicago, without any corresponding benefit to Canada. Is there one Canadian, indeed, primed with a knowledge of these facts, who believes that such a step would be beneficial to the scores of Canadian and American riparian towns and villages who rely upon the Great Lakes system for their water supplies?

Chicago is beset with troubles on all sides. Not only is it being blamed for injury to downstream interests, but it has to meet internal claims for damage alleged to have been caused by the additional amount of Lake water which the Illinois Valley is called upon to negotiate, notwithstanding that the extra water has the most beneficial effects on the sanitary conditions of the valley.

The levels of the Great Lakes have provided a problem of immense difficulty and super-complexity. It will not, however, daunt those who may be called upon to solve it if it is regarded solely as an engineering and scientific proposition and not as something akin to a *casus belli*. Unless both parties are able to keep themselves free from the international jealousies which have been introduced into the controversy, the best endeavours of the engineer and the scientist unfortunately can be of little avail. If a slogan is required to help on the way to a permanently acceptable solution, it might very well be found in the words: "Leave it to the engineers."

A PAVING machine worked by a petrol motor of 2 horse-power, which has been invented by a Swedish engineer and is manufactured by Aktiebolaget Svenska Gatumaskiner, is arousing considerable interest in Sweden. The machine is said to work both economically and efficiently.

A Continuously-variable, Chain-driven, Change-speed Gear.

It is claimed by the makers of the gear illustrated herewith that it is the only form of change-speed gear at present in existence which, while being positive and wholly mechanical in all its parts and action, gives, over the range for which it is designed, a continuously variable speed without steps and without dependence upon a frictional drive at any point. This positive, infinitely variable gear, as it is described, is British throughout in inception and production and is manufactured by the P.I.V. Gear Syndicate, Ltd., of 7, Princes-street, Westminster, S.W. 1. It has already been applied in the bakery, confectionery, and biscuit-making industries and in connection with the manufacture of cement, paper, electric cables, cotton and artificial silk. Immediate applications are in view for the gear in various branches of the textile industry, in the woodworking, gas-making and rubber industries, in connection with conveyors, lifts and winches, for the driving of machine tools and motor cycles, and so on, while its adoption for the drives of motor and electric vehicles is, we are told, a possibility of the near future.

The gear is intended not only for the transmission of one or two horse-power, but is already being made in two standard sizes, the larger of which is designed to transmit a rated horse-power of 15, while gears to deal with 25, 30, 40, or even higher horse-powers are, we understand, within the field of commercial practicability. The advantages claimed for the gear, in addition to its continuously variable speed characteristic, are the absence of slip, the small cubic space which it occupies, its silence, the fact that it is totally enclosed and runs in oil, and the fact that thermal changes do not affect it. The standard gear rated at 15 horse-power is contained in a cast iron box measuring 29in. long by 13¼in. wide by 14¼in. deep. With the constant-speed shaft running at 600 revolutions per minute it gives a 6 to 1 speed range for the driven shaft, namely, from 1500 down to 250 revolutions per minute with an infinite number of intermediate speeds. The smaller standard gear at present being made is rated at 5 horse-power and is contained in a box measuring 20½in. by 10½in. by 10in. With the driving shaft running at 750 revolutions per minute the speed range of the driven shaft extends from 1800 to 300 revolutions per minute. The gears, it is claimed, will withstand considerable overload and suffer no harm by being started under an overload. The powers we have named are continuous ratings, while as regards the speeds modifications can readily be made to reduce the range of variation if desired. If an increased range of variation is required back gearing as shown in Fig. 7 may be added outside the box, which, when it is thrown into engagement, may, as in the example illustrated, increase the speed range to 25 to 1 or more.

The general principle of the gear is familiar as applied to change-speed arrangements employing a leather belt. The driving and the driven pulleys each consist of two cones mounted on a key on their respective shafts and capable of being moved on that key away from or towards each other. Two blades on each side of the pulleys are, as shown in Figs. 1 and 2, mounted on pivots within the box in such a way that when an external handle is turned the cones on one shaft approach each other, while the cones on the other move apart. The angle between each pair of cone faces is 30 deg. Each cone, as will be gathered from Fig. 2, consists of a backing piece in the form of a conically flanged boss and a dished face attached by screws to the flange of the backing piece. To facilitate and cheapen manufacture the backing piece is made of cast iron, while the face is dished from a mild steel plate, which, after being machined, is case-hardened to glass hardness. On the surface of the face pieces radial grooves are cut. Each pair of cones is assembled on its shaft with the grooves of one face piece opposite the teeth of the other face piece. It may also here be noted that the grooves, while they decrease in width towards the apex of the cone, maintain the same depth throughout their length. It may in addition be remarked that the edges of the grooves—that is, the flanks of the teeth—are not normal to the conical surface, but are inclined at 30 deg. to it. The grooves and teeth are of equal dimensions.

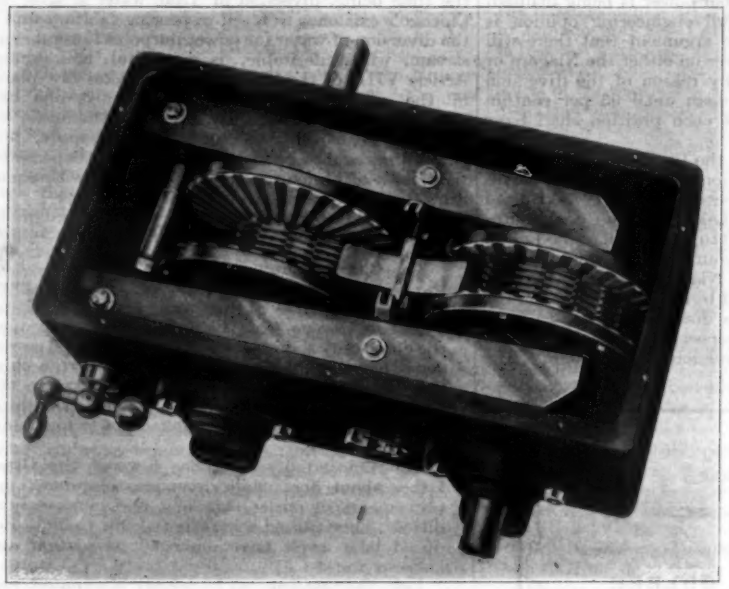
Were an endless vee-sectioned belt applied to the pulleys a frictional continuously variable speed changing arrangement on the familiar principle would be obtained, the highest speed being given when the driving shaft cones were closest together and the driven shaft cones farthest apart. As the external handle was turned the driven shaft speed would fall off, for the belt would creep in to a smaller diameter on the driving cones as they separated and move out to a larger diameter on the driven cones as these cones approached each other. The tension in the belt would not remain constant. It would be least when the ratio of the transmission was 1 to 1 and would increase on each side of this setting.

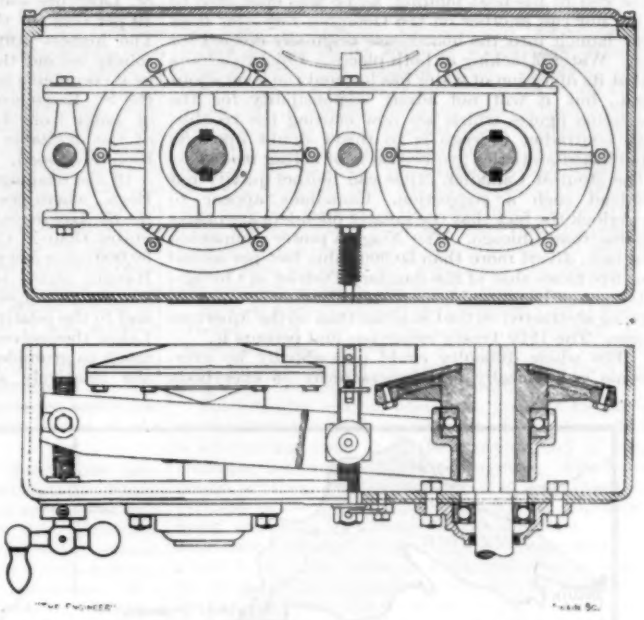
Instead of a belt dependent upon friction and therefore untrustworthy if the driven shaft is to operate entirely without slip the gear we are dealing with employs what can best be described as a self-pitching chain. The pitch of the teeth on the conical faces decreases from the periphery towards the conical apex. Hence for a chain drive to be practicable the chain must be such that it can automatically accommodate its pitch to the pitch of the teeth at the diameter of the cones at which it is riding. In addition the chain, except in the 1 to 1 setting, must be capable of automatically changing its pitch in passing from the driving to the driven pulley and again when passing from the driven to the driver. The chain employed in the P.I.V. gear fulfils these requirements. It is not only an ingenious device constructionally, but is one which, it is claimed, lends itself to economical production on a commercial basis and which possesses features which, it may reasonably be believed, must promote its longevity.

The upper and reverse sides of the chain are shown in Fig. 3, and in Fig. 4 the parts of which it is composed are illustrated. An assembled element of the chain is represented at A in Fig. 4. It consists of a casing B, over which a series of links C is passed and within which a series of thin slats D is inserted. These slats, of which there may be two dozen or more, according to the size of the chain, are free to slide on one another across the width of the chain, their movement in either direction being limited by small projections at their ends which abut against the edges of the casing B. The total crosswise movement which the slats may execute is approximately equal to the depth of the teeth on the conical faces of the driving and driven pulleys. At each end of the bundle of slats is an extra stout slat E formed of half-round material and with its ends milled off to an angle of 30 deg. The endwise movement of the slats is automatically produced by the engagement of the chain with the pulley, the teeth on one conical face pushing the slats over into the gaps on the other conical face. The stout end slats with their bevelled ends assist the movement by relieving the thin slats of shock at the instant of first contact.

Perhaps the best way in which to appreciate the action of the chain is to image it as composed of an endless series of the slats D and of nothing else. The slats are, we may take it, each one-fiftieth of an inch thick. If at the radius at which the chain happens to be working on the driving pulley the teeth and gaps are ¼in. wide, then as the chain passes on to the driving pulley a group of twenty-five slats will be moved to the left, the immediately succeeding twenty-five slats will be moved to the right, and so on in equal-sized groups in alternate directions. The leftward moving groups will fill the gaps on the left-hand coned face of the pulley and the rightward moving groups the gaps on the right-hand face. The last slat of each group will make driving contact with the flank of the tooth following the gap in which the group lies and will be backed up by the preceding twenty-four slats in the group. The slats will remain in this group setting as they pass round the driving pulley and will reach the driven pulley with the grouping substantially unaltered. At this pulley the chain, we will suppose, is working at a radius at which the teeth and gaps on the coned faces are a quarter of an inch wide. The slats, therefore, on reaching the driven wheel re-group themselves to fill the reduced size of the gaps.

Our example illustrates a minor but important point. Twelve and one-half slats would be required to fill the gaps on the driven pulley. The movement of the thirteenth slat is therefore ambiguous. It cannot be allowed to jamb itself into the half space available in the gap. If moving over to the opposite side it inserts itself as the first slat in the succeeding gap, it will separate itself from its neighbour in front by one-hundredth of an inch. If there are, say, twenty groups in engagement with the pulley simultaneously the effect will be equivalent to a stretch of the chain by one-fifth of an inch. This stretch in our example would occur only in that part of the chain in engagement





FIGS. 1 AND 2—GENERAL VIEW, ELEVATION AND HALF PLAN OF P.I.V. CHANGE SPEED GEAR

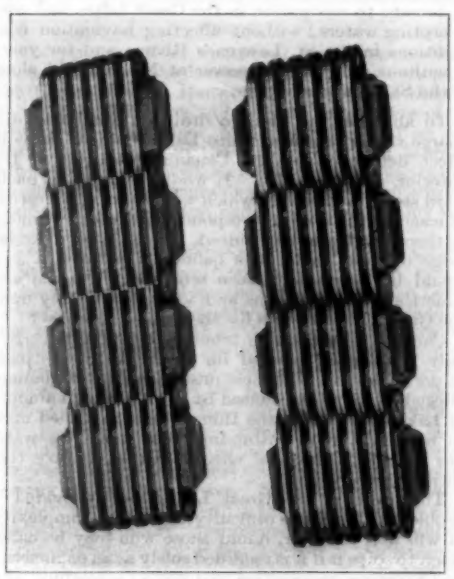


FIG. 3—SELF-PITCHING CHAIN

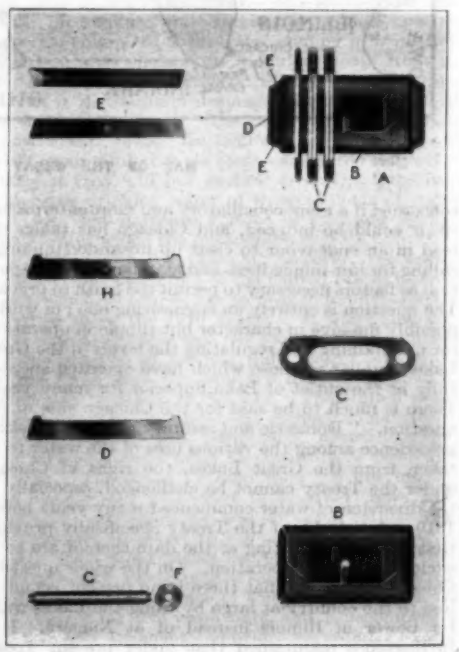


FIG. 4—COMPONENT PARTS OF CHAIN

with the driven pulley. It would give rise to a slip-like effect which would result in the speed curve being not continuous, but minutely stepped. The difficulty here indicated is overcome by inclining the flanks of the teeth at 30 deg. to the conical faces, a procedure which enables the thirteenth slat in our example to occupy a midway position. In other settings some fraction of a slat other than a half is required to fill the gap. In such cases more than one slat is accommodated by the 30 deg. flanks in a partially displaced position. In general, therefore, the slats are not displaced in sharply defined groups. The first and last two or three in each group suffer a stepped or fan-like displacement. It is claimed that the bevelling of the teeth flanks to 30 deg. gives a speed curve which is completely continuous.

An interesting and important practical fact may here

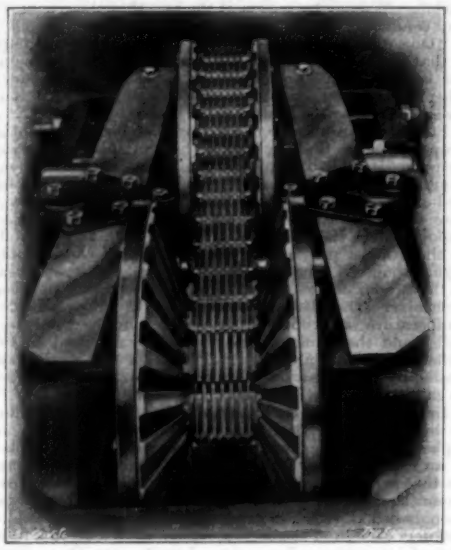


FIG. 5—CHAIN ON SMALLEST DIAMETER OF PULLEY

be mentioned. The slats which at any given instant are making driving contact with the teeth flanks will not in general make such contact again until the chain has run round the pulleys several or many times. All the slats in a regular order—not necessarily arithmetical—make driving contact with the teeth flanks and consequently the chain wears uniformly.

The chain as actually made consists in effect of groups of slats separated by intervals of about the same length as that occupied by the groups. This interruption of the slats is necessary in order to accommodate the links and rivets required to render the chain capable of transmitting tension. The action of the chain is, however, similar to that which we have pictured in connection with the theoretical chain consisting only of slats. As shown in Figs. 5 and 6, the non-continuous arrangement of the slats

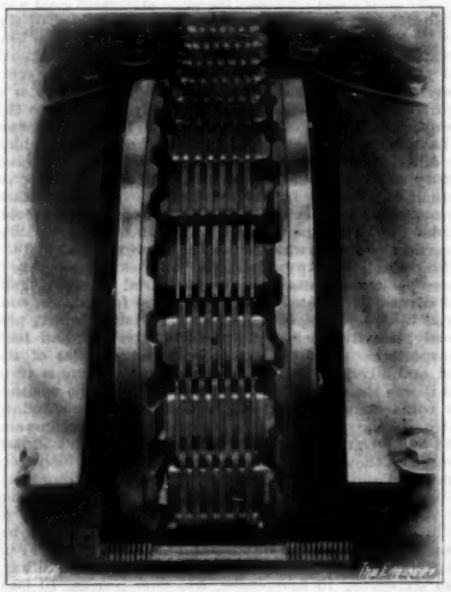


FIG. 6—CHAIN ON LARGEST DIAMETER OF PULLEY

may result in some of the teeth gaps being incompletely filled, and as a consequence some of the driving contacts may be omitted, while in others the contacting slat is backed up by less than the full theoretically possible number of slats. The number of actual driving contacts is, however, in all settings sufficient to transmit the power without overloading the slats and the strength of the half-round end slat is sufficient to prevent damage even although it and but one other slat are called upon to transmit the driving pressure.

Most engineers, on being introduced to the gear, will, we believe, focus considerable attention on the production of the chain. Its manufacture, we are assured, has now been reduced to a commercial basis. Of the parts shown in Fig. 4 the casing B is blanked from strip steel and folded into form in three operations. It is subsequently lightly case-hardened. The links C are stamped from mild steel sheet and are left soft in order that they may withstand jars and shocks. The washers F are stamped and are left soft. The rivets G are made in an automatic lathe and are case-hardened. The slats D are stamped from spring steel and are tempered in an electric furnace of the Wild-Barfield type. The end slats E are cut off from half-round tool steel strip, the bevel on the ends being milled, and are tempered electrically. The sides of the slats D are not perfectly flat, but are convex. In addition, the section of the slats is tapered. The slats, therefore, accommodate themselves to the curvature of the casing B, as seen in the end view, which curvature corresponds with that of the opening in the links C. Further, the slats are enabled to rock slightly on each other and to make a true line contact with the flanks of the teeth. To obtain the required convex tapered section the slats are stamped from strip material rolled to the appropriate form.

The assembly of the chain elements looks difficult, but is not really so. The majority of the slats can be inserted in the casing flatwise and then turned round, while the remaining few can be inserted with very little force against the spring of the casing. The end slats are then pushed into position and the links are threaded over the casing. The last of the thin slats H at each end of the group is formed with a central pip which, engaging with a depression in the end slat E, holds that member in position. To simplify manufacture these pips and depressions are being omitted, for it has been found that without them the friction on the end slats is sufficient to keep them in position while the chain is being handled. The assembly of the element is completed by turning up a tongue on the underside of the casing between two of the links to prevent the links from slipping off sideways. Alternate elements have the tongues in alternate positions, but by forming two tongues on each casing and using only one, duplication of the dies for making the casings is avoided. We may remark that we have handled full-sized samples of the chain and can vouch for the fact that none of its parts after assembly has the least tendency to fall out or come adrift. The chain can in fact be handled in every way as freely as an ordinary sprocket chain.

The undersides of the casings are, it will be noted, left open. The rims of the driving and driven pulleys run in oil, and as the pulleys revolve oil is splashed on to the chain. The lubricant finding its way through the openings in the backs of the casings flows between the slats outwards on to the teeth. It is claimed that this flow of the oil renders the slats self-cleaning.

The proper lubrication of the slats from the point of view of reduction of friction is important, but is not by any means vitally so. The driving tension in the chain is transmitted through the links and rivets and does not compress the slats against one another. Compression among the slats occurs under the reaction of the teeth on the pulleys, but while this compression is in action the slats are stationary across the width of the chain. The movement of the slats which results in the automatic formation of the pitches on the chain occurs before the point of tangency is reached, when, that is to say, there is little or no pressure on the slats. Consequently the frictional power lost in the cross movement of the slats is very slight.

The tight side of the chain is the underneath side. As has already been indicated, the length of chain theoretically required varies with the speed setting. With a constant length of chain maximum slackness is developed at the middle or one-to-one setting. To take up the variable amount of slackness a jockey pulley or its equivalent may be applied to the chain. Figs. 1 and 2 show such an arrangement, namely, a spring-loaded slipper pressing on the top side of the chain. An alternative arrangement preferable in some applications is illustrated in Fig. 5. In this case the centres about which the controlling blades swing are not fixed, but are subject to a small automatic movement under the action of a cam. If the centres are brought together or moved apart the effect will be to tighten up or loosen the chain. The cam effects the correct movement of the centres automatically as the speed change handle is turned.

In either case, in order that any stretch that may in course of time develop in the chain may be taken up, a right and left-handed screw motion is provided whereby the blade centres can be made to approach each other. Any such adjustment will naturally affect the speed ratio obtained at a given setting of the blades. It will tend to reduce the maximum speed ratio obtainable. But the effect will only be slight, for an approach of the centres of $\frac{1}{16}$in. is sufficient to take up a stretch in the chain of nine-sixteenths. In any event no loss of maximum speed ratio will be observed, for there is sufficient margin left on the pulleys to restore the maximum speed ratio to the original rated value after the adjustment for a considerable amount of stretch has been made.

The engraving Fig. 7 shows a development supplied to meet a demand for a speed range in excess of the standard 6 to 1 ratio. The range required was 25 to 1. Two standard boxes in series would have given a range of 36 to 1, but it was found to be cheaper and more economical of space—a prime consideration in this instance—to fit back gearing to the driven shaft in order to lower the lowest speed obtainable to the required figure.

Another and more interesting development can only be briefly described for the present. An Italian artificial silk factory required a gear which would reduce the driving speed of its bobbins progressively with the winding on of

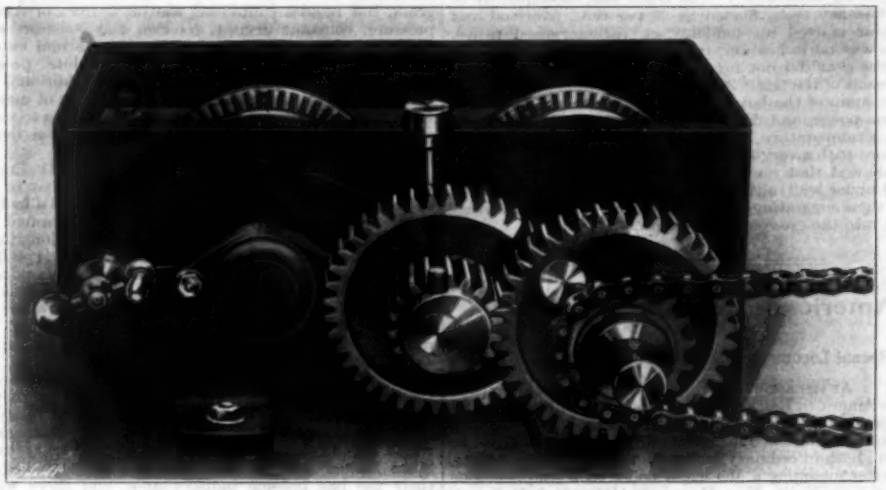


FIG. 7—CHANGE SPEED BOX FITTED WITH EXTERNAL BACK GEARING

the thread and so preserve the tension in the thread constant as the size of the reel increased. The P.I.V. gear supplied in fulfilment of this object as demonstrated to us recently is capable of varying the speed automatically and uniformly from 320 to 280 revolutions per minute over a period of three-quarter hour and on the operation of a press button of restoring the original speed of 320 revolutions in a matter of four seconds. In this application both sides of the driving pulley and one side of the driven pulley are made fast with their shafts. The second side of the driven pulley is mounted to slide on its shaft and is advanced towards its mate by means of a screw which, through a train of gear wheels, deriving power from the driving shaft, is caused to make about $2\frac{1}{4}$ turns in three quarter hour. The gear wheel train includes two wheels differing by unity in the number of their teeth. These wheels are driven by a common pinion and by their relative rotation turn the controlling screw at the required slow rate. During the interval a gramophone spring between the two gear wheels is slowly wound up. At the end of the interval a touch on a press button operates a dog clutch in the common pinion and separates that pinion into two parts. Under the action of the gramophone spring the wheel with the extra tooth is free to recover its lost relative motion and to wind the screw back through the $2\frac{1}{4}$ turns communicated to it.

Other applications of the system are being applied or developed. We may mention one in particular by way of illustrating the fact that the invention does not necessarily entail the use of an enclosed housing. This application consists of an open chain drive for an electric motor. On the motor shaft running, say, at 1000 revolutions per minute a two-part pulley is mounted with one half made moveable towards or away from the other by means of a concentric hand wheel and screw. On the driven shaft is a large pulley, both halves of which are made unmovable. The pulleys are coned and toothed in the standard manner and the chain is of the standard self-pitching type. The

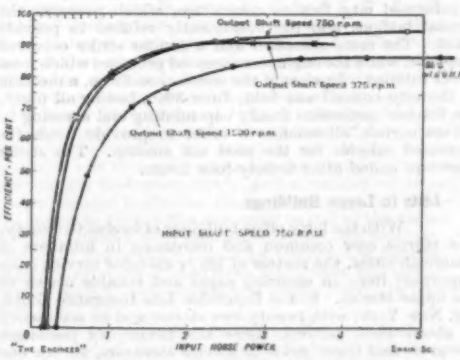


FIG. 8—N.P.L. EFFICIENCY CURVES

normal speed reduction of the drive is 2 to 1, but by adjusting the movable half of the pulley on the motor shaft any speed from 500 down to 250 revolutions per minute can be obtained at the driven shaft. A jockey pulley swung from the driven shaft is applied to the chain to take up the slack. This arrangement seems to provide a simple and effective method of obtaining a speed variation over a considerable range from an electric motor, the characteristics of which are such as to render such variation difficult or impossible in a direct manner.

On the all-important question of efficiency we may quote the results of some tests made at the National Physical Laboratory on a standard gear-box rated to transmit 5 horse-power and designed to work with a con-

stant input speed of 750 revolutions per minute. For the purpose of the tests the Laboratory drove the box by means of a motor dynamometer and absorbed the output by a Froude brake. Curves of the efficiencies attained at output speeds of 375, 750, and 1500 revolutions per minute are given in Fig. 8. At or about full load it will be noted the efficiency at an output speed of 750 revolutions per minute—that is at 1 to 1 ratio—reaches 95 per cent. At 375 revolutions per minute output speed, 2 to 1 ratio, the efficiency attained is 91 per cent., and at 1500 revolutions per minute, 1 to 2 ratio, the maximum efficiency is 87 per cent. The estimated accuracy of these efficiency figures is given as $\pm$ 0·5 per cent. Preliminary tests showed that the gear could transmit 20 per cent. overload at the highest and lowest speeds of the output shaft without giving trouble or requiring adjustment. The brake was, subsequently to the efficiency tests, loaded to 25 per cent. overload and the gear started up suddenly at various speed ratios. There was no indication, the Laboratory's report states, that the gear did not function properly or was damaged as a result of the test. A thermo-couple inserted in the oil in the sump of the box showed after a run of 1½ hours at 5 horse-power and 1500 revolutions per minute output speed a temperature 7 deg. Cent. above atmospheric temperature with a very slow rising tendency. A stroboscopic test showed that no slip occurred between the chain and wheel under load, although as the load was applied there were signs suggesting that the chain wedged itself farther down into the grooves of the cones.

American Engineering News.

Recent Locomotive Developments.

At the annual meeting of the mechanical division of the American Railway Association a committee reported on some of the important developments in locomotive design. One of these is the use of pressures of 250 lb. to 350 lb., both in ordinary boilers and in water-tube boilers, the latter including a McClellan boiler on a simple engine of the New York, New Haven and Hartford Railroad, and a Brotan boiler on an experimental three-cylinder compound for another railway. As a result of a year's experience with the "Horatio Allen" cross-compound heavy goods engine with 350 lb. pressure on the Delaware and Hudson Railroad, slightly modified designs have been made for additional engines of this class, but carrying 400 lb. pressure, with superheat of 700 deg. total temperature. At the 350 lb. pressure there has been no trouble with cylinder or rod packing. As to the increasing use of three-cylinder compounds, the report cited sixty-two, including passenger, goods and shunting engines, and there has been only one crank axle failure. One of the builders claims advantages over two-cylinder engines of equal weight on drivers of 15 per cent. more hauling power, 15 per cent. in fuel economy for performing the same work, and a boiler capacity 15 per cent. less for the same work. Another interesting development is the introduction of oil-electric locomotives and rail motor cars for special conditions, but there is no indication that they will replace the steam locomotive or check the improvement of the latter.

Municipal Engineers' Strike.

A new phase of professional ethics is presented by a strike of some 500 technical engineers and draughtsmen in the various departments of the city of Chicago, which was begun on June 30th as a protest against the city's continued failure to make an adjustment of salaries. Their pay is practically the same as it was before the war, while prices and rents and all expenses have increased enormously. The request has been made repeatedly that the city should adjust the salaries so that they would be at least on the pre-war purchasing basis. General construction work would soon be shut down by lack of inspecting engineers, building work would be similarly affected by lack of men to inspect and pass plans submitted for approval, and the technical work of the health department would be checked, as would be all work of designing and planning in all departments. Certain men in responsible positions remained on duty, and the strikers made provision for the supply of engineers to take care of any emergency. The trouble was the hostile attitude of an ill-informed city finance committee, which prepares the annual budget, and has consistently refused to provide relief. The same situation and a similar strike occurred last year, when the engineers accepted promises which were never fulfilled. In view of the serious condition, a meeting of the city council was held, June 30th, lasting all night, the finance committee finally capitulating and agreeing to reduce certain allotments in order to provide funds for increased salaries for the next six months. The strike therefore ended after twenty-four hours.

Lifts in Large Buildings.

With the lofty office buildings of twelve to twenty-five stories now common and increasing in numbers in American cities, the matter of lift or elevator service is an important item in ensuring rapid and reliable access to the upper stories. In the Equitable Life Insurance Building, New York, with twenty-two stories and an occupancy of about 6000 persons, there are twenty-six passenger elevators and three goods or service elevators, all but one of which have a car speed of 600ft. per minute. The twenty-four main passenger elevators are arranged in four groups of six cars each, with two groups on each side of the main entrance hall. The car has a floor area of 36 square feet and a maximum load capacity of 3600 lb. For effective speed regulation these electrically operated elevators are equipped with a new variable-voltage control system known as the series-exciter control. Besides the hand-operated emergency switch and an automatic slow-down and stop at terminals, there are automatic emergency stops for different possible failures. All of these operate by opening the motor armature circuit and application of emergency dynamic braking, as well as an instantaneous application of the solenoid brake. For effective service to the upper floors some of the "express" cars do not stop between the first and tenth floors, while "local" cars run only between the first and tenth floors.

A New Steam Chart.

By the courtesy of the British Electrical and Allied Industries Research Association we have received an advance proof of the new steam chart prepared for the turbine section of the Beama. The chart has been plotted by Professor Callendar from the data contained in his enlarged steam tables, which give the properties of steam at pressures ranging up to 2000 lb. per square inch. These tables are taken as standard by British engineers, and the new chart forms a fitting, not to say necessary, complement to them. Like the tables, the chart is based on the foot-pound-Fahrenheit system of units. It is essentially a "Mollier" or "total heat-entropy" diagram, but besides containing the usual lines of constant pressure, constant dryness fraction and constant super heat, it has also lines of constant volume and constant total temperature. Moreover, for absolute pressures below 2 lb. per square inch, there are additional lines corresponding to vacuum measured in inches of mercury. For ease of reading, the lines and figures relating to volume and superheats are printed in red, while the lines of vacuum are dotted.

Exclusive of margins, the chart measures 31·5in. long by 26in. high, the longitudinal scale being that of total heat and the vertical scale that of entropy. To facilitate the use of the chart, it is printed upon a background ruled with millimetre squares in faint blue. On the longitudinal scale, 1 mm. corresponds to a difference of 1 B.Th.U. per lb., and on the vertical scale 5 mm. corresponds to one-hundredth of an entropy unit. The chart deals with steam ranging from 2000 lb. per square inch at a temperature of 1000 deg. Fah. down to a vacuum of 29·6in. It is published by Edward Arnold and Co., at the price of 4s. net.

The publication of this chart provides engineers for the first time with a diagram by means of which they can obtain rapid and graphic solutions of problems relating to the use of steam at the highest pressures and temperatures which are in use or even under consideration to-day. Since Mollier first devised total heat-entropy diagrams, their use has become indispensable, and there was an urgent need for one which would cover the range of modern pressures and temperatures. Moreover, the auspices under which the present chart has been produced are sufficient to inspire confidence in its accuracy, so that it cannot fail to meet with a cordial reception.

That the form in which it appears has been the subject of earnest consideration by a competent body of men cannot be doubted, yet in view of previous practice, one may be permitted to question the wisdom of certain details. The quantity most commonly sought from such a diagram is the heat rendered available as work by a fall from a higher pressure to a lower one. This "heat drop" is read most naturally on a vertical line, and to enable that to be done the total heat scale must be vertical instead of horizontal, as in the present case. In the total heat-entropy chart, ranging up to 750 lb. pressure, recently published in *Mechanical Engineering*, the heat drop is read vertically, and that is not only the obvious and sensible thing to do, but we believe most engineers will find a diagram confusing in which it is not done. It is true that in a most excellently proportioned and widely used total heat-entropy diagram published a good many years ago by Moyer, the total heat scale was horizontal, but even then Moyer did the next most natural thing and made the heat drop read from left to right. For no apparent reason whatever, on the new Callendar diagram heat drop has to be read, not only horizontally, but also from right to left, so that the chart has an unfamiliar and confusing appearance whichever way one may turn it round. This, perhaps, is a small point, and one which users may soon adapt themselves to, but to those accustomed to the conventions it is somewhat puzzling at first.

Binary Heat Engines.

In view of the great amount of attention which is now being given by engineers to the subject of binary heat engines, that is to say, prime movers utilising two fluids, the condensation of one of them being employed in the evaporation of the other, the following extracts from a paper contributed to the American Society of Mechanical Engineers, by Dr. H. H. Dow, of Midland, Mich., are of topical interest. Dr. Dow is president of the Dow Chemical Company, which manufactures diphenyl oxide, the primary fluid which he recommends, for perfumery purposes, and it is noteworthy that its cost is not exorbitant.

In his paper Dr. Dow states:—"Diphenyl oxide is a white solid at room temperature, but a liquid if it contains a slight amount of impurity. It melts at 81 deg. Fah. when very pure. The fact that it is a solid is a slight objection, but any part of the boiler-room where it would be used would have a temperature above 81 deg. Its specific gravity is 1·083, and its boiling point at atmospheric pressure is 258 deg. Cent. or 496 deg. Fah., which is the temperature of saturated steam at 680 lb. pressure.

"At 200 lb. pressure its boiling point is 800 deg. Fah. Its specific heat is approximately 0·4. Its critical pressure is 465 lb. at a temperature of 530 deg. Cent., or almost 1000 deg. Fah. Another physical property not often recorded in the tables is its price. In quantity lots it is worth 30 cents a pound. It can be produced in unlimited quantities, and the cost per unit volume is less than 2 per cent. of the cost of the same volume of mercury. This is one principal reason for advocating diphenyl oxide in bi-fluid power systems.

"One of the thermodynamic properties of diphenyl oxide is that in an ordinary turbine where it expands adiabatically, instead of condensing like water it superheats to a marked degree, even in a 100 per cent. efficient turbine. For example, when the vapour expands from 135 lb. gauge down to atmospheric pressure where the boiling point is 500 deg. Fah., the temperature, instead of being 500 deg. is about 625 deg.

"This extreme amount of superheating has an advantage and a disadvantage. It is difficult to transfer heat from a superheated vapour. Accordingly, when this vapour is exhausted at 625 deg. it is necessary to use it regeneratively to heat the boiler feed in order to get 90 per cent. of the Carnot cycle, otherwise the efficiency of this cycle would be only 75 per cent. We have 15 per cent. as the goal to be gained by using regenerative heating, that is, taking the exhaust superheat from the turbine and using it for reheating the boiler feed, which corresponds to bleeding in an ordinary steam installation. A certain amount of this can be done, but whether or not it can be brought up to 90 per cent. without prohibitive expense has not yet been demonstrated.

"Another advantage of diphenyl oxide is that the weight of its vapour is about 9·4 times that of steam vapour. This means that a diphenyl-oxide turbine will run at a lower speed with higher torque for the same horse-power than a steam turbine, which is a great advantage. It may be that on that account we shall get a little higher turbine efficiency, and we shall certainly get some higher turbine efficiency by reason of the fact that there is never any condensate in the vapour.

"One difference between diphenyl oxide and mercury is that the latter does not wet steel, and on this account the boiler tube may get much hotter than the mercury; whereas diphenyl oxide does wet the tube, so that it is easier to transfer the heat from the boiler to the liquid."

For those various reasons Dr. Dow feels very confident in proposing the diphenyl-oxide bi-fluid plant working between 750 and 70 deg. Fah. The diphenyl-oxide vapour would be generated in a boiler at 135 lb. gauge pressure and expanded to a vacuum depending on the steam pressure with which it is desired to work. The saturated vapour enters the turbine at 750 deg. Fah. and expands to the exhaust pressure with a temperature considerably higher than the condensing temperature. The superheat in the vapour is then removed in a counterflow boiler-feed preheater. The heat of vaporisation at the condensing temperature is given up to the water in the condenser boiler and the liquid diphenyl oxide is returned to the boiler through the preheater. The steam should be superheated by direct heat or by diphenyl-oxide vapour in order to gain the increase in the efficiency of the turbine.

In replying to the discussion which followed the reading of his paper, Dr. Dow, dealing with the instability of diphenyl oxide when heated, said that some of it was boiled in an iron boiler for a month at 830 deg. night and day. At that temperature there was some decomposition after a month—in the neighbourhood of 1 or 2 per cent. It was then boiled at 135 lb. pressure, which corresponded to 750 deg. Fah., and the decomposition decreased to a fraction of 1 per cent. For a given horse-power, the volume of a diphenyl-oxide boiler will be the same as that of an equivalent steam boiler. However, the former boiler is distinctly different on account of the very low latent heat of diphenyl oxide. The tubes have to be short and it is necessary to have some special means of circulation, either a circulating pump or special construction to give maximum circulation. Diphenyl-oxide vapour against hot metal surfaces would be undesirable.

SIXTY YEARS AGO.

When did the Lord Mayors of London last count hobnails at Westminster and why did they do it? We regret that we are unable to supply the answer off-hand. Sixty years ago, on the evidence of our issue of August 24th, 1866, the performance had become an empty ceremony, the only point in its favour being that it was concluded with a dinner to the principal actors taking part in it. Equally empty and with only the same attendant good was, we contended, the ceremony entitled "The Trial of the Pyx." Such a trial, designed in far off days for the preservation of the standard of purity of the British gold and silver coinage, had been made with much musty ceremony on January 19th, 1866, and seven months later a report on the proceedings had been duly rendered to the Comptroller-General of the Exchequer. The report seems to have been an example of scholarly erudition, in which the author not only endeavoured to trace the origin and history of the institution, but sought to establish its past and current value. In the presence of sundry important personages and a jury of twelve men selected by the Goldsmiths' Company, the proceedings began by the unsealing of certain packages which since the previous trial in 1851 had reposed in the "pyx chamber" at Westminster Abbey. These packages contained standard trial plates of gold and silver. The plates were, after many formalities, conveyed by the jurymen to Goldsmiths' Hall, whither, previously, heavily laden pyx boxes from the Mint had been transported. The pyx boxes contained samples of the gold and silver coinage minted since the previous trial, and it was the duty of the jurymen to determine whether the coins compared in composition with the standard plates. In one pyx box the jury found 45,482 sovereigns and 4348 half sovereigns. Taking 224 sovereigns and 39 half sovereigns they melted the metal into ingots, which were hammered and rolled into strips. Samples cut from these strips were cupelled and then boiled in nitric acid, and the weights before and after treatment were noted "to the utmost carat." A similar treatment was accorded to samples cut from the standard plates as a check. From the other pyx box the jury took 2936 florins, 3367 shillings, 1006 sixpences, 10 fourpences, 545 threepences, 10 twopences and 30 silver pennies, and selecting 167 coins of various denominations, subjected them to a similar comparison with the standard silver plates. A verdict acquitting the Master of the Mint with respect to all coins he had made up to the close of 1865 was duly pronounced by the jury, and the proceedings closed with the customary dinner. We characterised the trial as a frivolous, vexatious and costly absurdity. It resulted in the retainment in idleness of large sums of money and gave a verdict on the purity of coinage which had for the most part long since found its way beyond recall. In the days of the moneyers' companies the trial might, we said, have been of some value, but it was now an unnecessary farce, for before, during and after minting the metals of which our coins were made were subjected to constant assaying and testing by several eminent chemists and others inside and outside the Royal Mint. Our condemnation of the procedure might have been stronger had we known that as discovered in succeeding years the standard trial plates were themselves below the legal standard of fineness to an extent corresponding to about £400 per million.

Railway Matters.

THE South Shields, Marsden and Whitburn Colliery Railway is one of the several old wagon ways to be found in Durham and Northumberland. It is now to be reconstructed with deviations in places, and converted into a light railway. For such a purpose an Order has just been sanctioned by the Ministry of Transport.

THE retirement, at the end of September, of Mr. W. J. Wakeman, the Belfast district engineer of the Great Northern Railway, Ireland, will lead to there being in future only two districts, with headquarters at Belfast and Enniskillen respectively. The signal superintendent and his staff will be removed to Dundalk and occupy the offices now in possession of Mr. H. A. MacGiffin, who removes to Belfast and takes over Mr. Wakeman's offices.

THE railway statistics for May of the Ministry of Transport, recently issued as a Stationery Office publication, reflect the general strike and the stoppage in the coal industry. Compared with May, 1925, there was a decrease of 47·8 per cent. in the number of passenger journeys, of 40·7 per cent. in the passenger receipts, of 78 per cent. in the tonnage, and of 61·8 per cent. in the freight traffic receipts. As a set-off against those losses there was a decrease of 53·7 per cent. in the passenger train miles and of 66·3 per cent. in the freight train miles.

THE Ministry of Transport is losing the services of a useful and popular officer in the retirement, at the end of this month, of Mr. A. R. Thomson. Mr. Thomson joined the Board of Trade in 1883, and entered its railway departments in 1892, where he rose to the position of one of the principal clerks. He was transferred to the Ministry of Transport, on its creation, in September, 1919. We write this personal reference as an appreciation of the courteous kindness always shown by Mr. Thomson when consulted on matters of railway legislation.

THE coast railway line from Lisbon to Cascaes through Mont Estoril, has now been electrified. This work, the first of its kind to be carried out in Portugal, will be a great boon to the many inhabitants of Lisbon who have summer residences on the route, as well as to those English people who go to Lisbon in the winter, for the electric trains do the journey in half the time that the steam trains used to take. The service only started this week, and it is not yet fully organised. The trains were operated by Germans during the trial runs, but have now been handed over to Portuguese drivers.

Two 2000-kilowatt rotary converters are to be installed in the Mansion House Underground sub-station, and to provide room for one of them, an existing 1500-kilowatt rotary converter is to be removed. The intention is to supply the eastern end of the Central London Railway from the sub-station, and thus to avoid addition to the size or number of sub-stations on that railway, which may be necessary to deal with future increases in the train services. The power of the new equipment at Mansion House will also provide a margin to cope with further increases in the District Railway train services.

WHAT the official report cryptically terms "a mechanical defect which made the running of the train unsafe," occurred to a passenger train at Hackney Downs Station, London and North-Eastern Railway, on the morning of the 19th inst., which caused no personal injury but led to considerable delay to traffic. As it was said that the permanent way was damaged, it may be assumed that it was a case of a broken axle or a broken tire. It may be noted that the last instance of a broken axle leading to a fatal passenger train accident occurred at Hackney Downs, but that was over twenty-four years ago—on April 25th, 1902.

WHEN the signal departments of the southern area of the London and North-Eastern were re-arranged after the grouping of the Great Northern, Great Central and Great Eastern, Mr. R. F. Bound, of the Great Central, was made the signal engineer; Mr. R. E. Tattersall, the signal superintendent of the Great Northern, was made assistant signal engineer; and Mr. C. Carslake, who was Mr. Bound's assistant when the latter was at Guide Bridge, remained there as his outdoor assistant. The signal engineer of the North-Eastern area, Mr. E. F. Flet, had, however, no assistant signal engineer so Mr. Tattersall was sent to York some months ago. That gentleman has now been confirmed in his appointment as assistant signal engineer, North-Eastern area, and Mr. Carslake has been appointed to the position of assistant signal engineer, Southern area.

DURING the month of July, 345 suggestions were submitted by the railway, omnibus and tramway staffs of London's Underground to the management, and of them thirty-two are to be adopted. The successful suggestions included a self-locking clamp for boiler-tube caps, which came from the Chelsea Power Station. Other suggestions were for an improved method of covering car lighting wires, &c., and for the improved lighting at Piccadilly Circus Station on the Bakerloo line. In connection with the Underground suggestion scheme, it is of interest to record that three members of the railway staff have been awarded special bonuses in recognition of the number of suggestions made by them during the past two or three years, which have been accepted and adopted. These bonuses are additional to the awards made in respect of each accepted suggestion.

ACCORDING to the Railway Returns for 1925, the Great Western locomotives consume the least quantity of lubricating oil per engine mile in passenger service, and the London, Midland and Scottish has the lowest in freight service. The London and North-Eastern engines consume the most in both services, but have the lowest record for shunting. The respective consumption in pints per 100 engine-miles was:—*In passenger service*: Great Western, 6·18; London, Midland and Scottish, 6·42; Southern, 6·72; London and North-Eastern, 7·91. *In freight service*: London, Midland and Scottish, 6·71; Great Western, 7·10; Southern, 7·97; London and North-Eastern, 8·20. *In shunting by shunting engines*: London and North-Eastern, 5·06; Great Western, 5·12; Southern, 5·95; London, Midland and Scottish, 6·21. *In all services*: Great Western, 6·42; London, Midland and Scottish, 6·53; Southern, 6·94; London and North-Eastern, 7·56.

Notes and Memoranda.

FOR the purpose of ascertaining the value of Huon pine oil in preventing decay in other woods, the Tasmanian Forestry Department is arranging to carry out lengthy experiments. A consignment of Huon pine sawdust is to be sent to Hobart, where the oil will be distilled, and the experiments carried out. Huon pine is a most remarkably durable timber, and this is doubtless due to the oil the wood contains.

OIL shale occurs abundantly at the Fushun coal mines in South Manchuria. The oil shale there overlies the coal beds, and is about 450ft. thick. The oil content is not uniform, being reported to be 5 per cent. on the average. It is roughly estimated that there are about 5000 million tons of oil shale available, and by approximate extraction of 5 per cent. of crude oil, the yield may be estimated at 1800 million barrels of oil.

WITH the arrival of the last air liner of Imperial Airways from Paris during the evening of the 24th inst., civil aviation completed seven years of regular airway operation. During this period British air liners have flown nearly 7,000,000 miles and carried over 60,000 passengers between London and the Continent. In 1919, when the London-Paris service was first opened, the number of passengers carried per week was under twenty, while this year in recent weeks some 1500 passengers have passed through the London Air Station weekly.

THE possibility of at least maintaining the normal strength of mortar or concrete by re-tempering is, says the *Canadian Engineer*, an alluring one. It has been found that in patching of concrete a re-tempered mix is very desirable, as the amount of shrinkage is much less than it is with a mix not re-tempered. Then, if the plan of manufacturing concrete at a central plant and transporting it, considerable distances develops, there will easily be with long hauls cases where re-tempering would be desirable. If it is known that this results not in a loss of strength, but in improvements in it, the flexibility of concrete construction will be greatly increased.

DURALUMIN can, according to *Machinery*, be readily welded by oxy-acetylene methods, but unfortunately in the use of autogenous welding processes there is a tremendous change in the structure and the physical properties of the piece welded. The high physical qualities of duralumin are due almost entirely to its ingredients and heat treatment, and if such heat treatment is either not applied or incorrectly applied, the results obtained are no better than from ordinary aluminium alloys. If a piece of duralumin, of high tensile strength obtained by heat treatment, is welded, it is obvious that the heat employed, 6500 deg. Fah. or 3593 deg. Cent., destroys the effect of the original heat treatment.

THE points to be borne in mind in surfacing any metal by building up with "Stellite" and an acetylene blow pipe are, according to *Industrial Gases*, first, to be assured that no blow holes are on the surface; the material should be properly cleaned, and, if possible, ground, to get as smooth a surface as possible. The surface should also be free from any cracks caused by uneven cooling. Before coating with "Stellite" the base metal should be pre-heated as in the case of a steel which is going to be worked and afterwards hardened and tempered, and where a large surface has to be treated the blow pipe should be so inclined as to sweep over the surface of the material, and the surface should only be treated partially at a time, *i.e.*, it should be treated in patches.

ACCORDING to the *Leather World*, a German chemist has discovered a means for producing tanning material from brown coal. The coal is first treated for the production of humic acid. Then 2 parts by weight of humic acid are introduced into 11 to 15 parts by weight of strong nitric acid, of 65 per cent. strength, and the mixture is then heated whilst stirring to 70 deg. to 80 deg. Cent. Nitrous oxide is evolved, the reaction being completed by prolonged heating. The excess acid is driven off by heating, and the remaining product dissolved in water and again heated to drive off any remaining nitric acid. In this way a water-soluble, amorphous body of reddish-brown colour is obtained, which precipitates gelatin; the substance, when dissolved in water, may be used directly or in conjunction with other synthetic or natural tanning materials.

THE total quantity and value of asbestos mined in the United States and sold in 1925 amounted to 1258 short tons, valued at 51,700 dollars. These figures comprise 93 tons of chrysotile asbestos, valued at 40,750 dollars, mined in Arizona and California, and 1165 tons of amphibole asbestos, valued at 10,950 dollars, mined in Georgia, Idaho and Maryland. The sales of chrysotile asbestos showed a decrease of 46 per cent. in quantity and an increase of 20 per cent. in value, compared with 1924, and the sales of amphibole asbestos were more than nine times as large in quantity and were 28 per cent. greater in value. Imports of unmanufactured asbestos for consumption amounted in 1925 to 230,520 short tons, valued at 7,134,302 dollars, and the exports were 1109 short tons, valued at 70,846 dollars. Corresponding figures for 1924 were:—Imports, 183,250 tons, valued at 5,602,945 dollars; exports, 1270 tons, valued at 93,163 dollars.

DURING the last three years waves of accurately known frequency have been transmitted, on the recommendation of the Radio Research Board of the Department of Scientific and Industrial Research, from the wireless station at the National Physical Laboratory, to provide a means of checking the calibration of wave meters and other apparatus. This transmission has consisted of eight waves covering a range 360 to 60 kilocycles per second (833 to 5000 metres wave length). It is transmitted between the hours of 1500 and 1600 G.M.T. on alternate Tuesday afternoons. In order to increase the usefulness of this service, arrangements have been completed, after consultation with the Post Office and others interested, for the present transmissions to be greatly extended. The new transmissions will include sixteen waves. These will be transmitted in two sections, each section being transmitted once each calendar month. One part will be transmitted on the first Tuesday in the month between 1500 and 1600 G.M.T., while the other part will be transmitted on the third Tuesday in the month between the same hours.

Miscellanea.

THE newsprint mill of the International Paper Company at West Templeton, Quebec, is to be extended by the addition of two new machines each capable of turning out paper 256in. wide at the rate of 1200ft. per minute.

THE tolls taken by the Panama Canal during the fiscal year which ended June 30th amounted to about £4,600,000, being an increase of £300,000 as compared with the previous year. March was the busiest month, and 506 vessels, carrying 2,607,046 tons of cargo, passed through the Canal in that month.

THE cruiser Tourville, the first French war vessel built with the full gun power permitted under the Washington Agreement, was launched at Lorient on the 24th inst. She is an armoured cruiser of 10,000 tons, 573ft. in length, and has a beam of 57ft. She is equipped with engines of 130,000 horse-power, and has a designed speed of 33 knots.

THE twin-screw steamer Kahanui, a tugboat built for the Wanganui Harbour Board, New Zealand, was launched on the 24th inst. from the slips of the Dublin Dockyard Company. Built by Vickers (Ireland), Ltd., she is the first boat launched under the Free State flag. She is 110ft. long by 24ft. beam, and will be towed to Glasgow for the installation of her propelling machinery.

THE *Board of Trade Journal* says that Lloyd's Register Book shows that there are forty vessels, with an aggregate displacement of 120,512 tons, employing electric motors connected to the screw shafts, the motors being supplied with energy from generators which are driven either by steam turbines or oil engines. The Book also records 3576 steamers, of a total of 18,243,539 tons, fitted for burning fuel oil.

A REPORT from Cologne states that after many delays the project for the construction of a canal to afford Aix-la-Chapelle a waterway connected with the Rhine, is about to materialise. The Labour Minister of the Reich has written to Herr Sinn, the Reich Deputy for Aix, informing him that the scheme has been approved, and that when the preliminary plans have been also approved, work can be commenced forthwith.

IMPORTANT construction works are about to be undertaken by the Federal Government at the Port of Mazatlán, in the State of Sinaloa, on the west coast of Mexico and a port of call of several steamship lines. An appropriation of 7,000,000 pesos—£700,000—has been made by the Government to cover the construction of a stone breakwater, 700 m. in length, the dredging of the inner harbour and the construction of a 300ft. steel and concrete pier.

THE Chilean Government will shortly call for plans, and subsequently for tenders, in connection with several irrigation projects for the Provinces of Atacama and Coquimbo. Congress will be asked to sanction an expenditure of 25,000,000 pesos, which will be returned in the form of rentals of Government lands in the Territory of the Magellanes. In the first-named district the Lautoro River will be canalised; in the second the construction of reservoirs and the impounding of the waters of the Laguna and Gogoti Lakes will be undertaken.

THE keel of what, it is claimed, will be the first large electric passenger ship was laid at Newport News, Virginia, on March 20th, at the plant of the Newport News Shipbuilding and Dry Dock Company. The new liner will be 601ft. long, with an 80ft. beam, and will have a speed of 17 knots. Oil-fired boilers will furnish steam to two 9000 horse-power turbine generators, which in turn will supply the motors connected to the two propellers. The electrical equipment is now being manufactured at the Schenectady plant of the General Electric Company of America.

WHEN she arrived at Plymouth early in the morning of the 24th inst., the Cunarder Mauretania completed the double crossing of the Atlantic in 12½ days from the time she left Cherbourg on her outward voyage. On this occasion the Mauretania was alongside the Cunard pier in New York for only thirty-one hours; during that time the westbound passengers were disembarked and the eastbound passengers embarked, stocktaking of stores carried out, the ship stored again for the return voyage, 5000 tons of oil fuel taken on board, 75,000 pieces of linen collected and washed, and the ship cleaned from stem to stern.

IN commenting on the report by Colonel J. W. Pringle on the unfortunate accident which occurred at St. Margarets, Edinburgh, during the General Strike, the *Electrician* points out that the report discloses one feature to which attention has often been directed. The accident occurred in a tunnel, and after the collision there was an escape of gas due to the perforation of the gas cylinders and the breakage of the gas pipes under two of the vehicles. Fortunately the precaution was taken to use electric lamps in the rescue and clearing work and no fire resulted. Nevertheless the gas dissipated slowly, and a number of those who were engaged in clearing the wreckage were overcome by the fumes so that it was necessary to call in the assistance of the military with their gas masks. The company, it is stated, is fitting all its new stock with electric lighting, but a great deal of gas-lighted stock is still used, and though experience shows that conversion is taking place, the pace is exceedingly slow.

AS soon as the recently constituted National Railway Company, to which the Belgian State Railways have been leased, has started working, the Government will make a similar arrangement with regard to the telephones and telegraphs, which are at present operated by the State. The company which will be formed will be given the right to exploit the telegraph and telephone system for a limited term of years. The value of the system will be estimated at 1,800,000,000 francs, and the capital of the company will consist of Preference shares, which will be offered to the public to the amount of 1,500,000,000 francs and of Ordinary shares of the value of 300,000,000 francs, which will remain the property of the State. Parliament will be asked to ratify this project before the end of the year. The net receipts of the Belgian telegraph and telephone system amounted in 1924 to 117,000,000 francs. By means of a suitable raising of the rates it is hoped that the total receipts will rapidly reach the annual figure of 234,000,000 francs.

SOUTHAMPTON DOCKS—AUTOMATIC MOTOR-CONTROL GEAR

ELECTRIC CONTROL, LIMITED, GLASGOW, ENGINEERS

(*For description see page 214*)

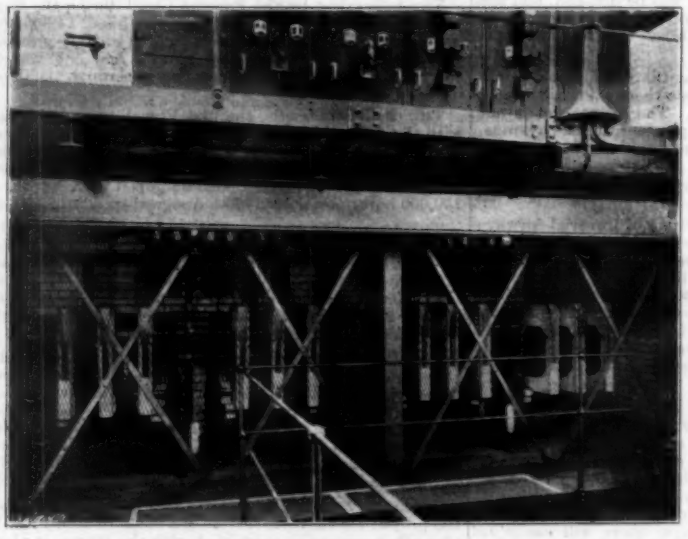


FIG. 15—TRIPLE-POLE HIGH-TENSION CONTACTORS FOR 950 H.P. A.C. MOTORS

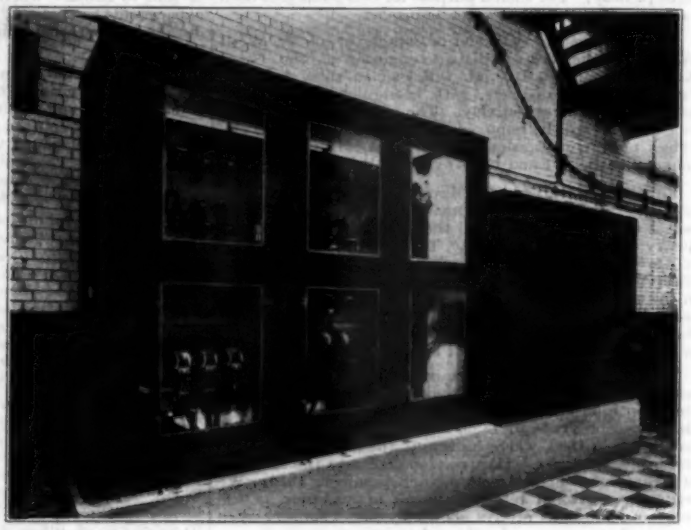


FIG. 16—CONTACTOR PANEL AND RESISTANCE FOR 1200 H.P. A.C. MOTOR

FIG. 17—CONTACTOR CONTROLLER FOR 1200 H.P. D.C. MOTOR

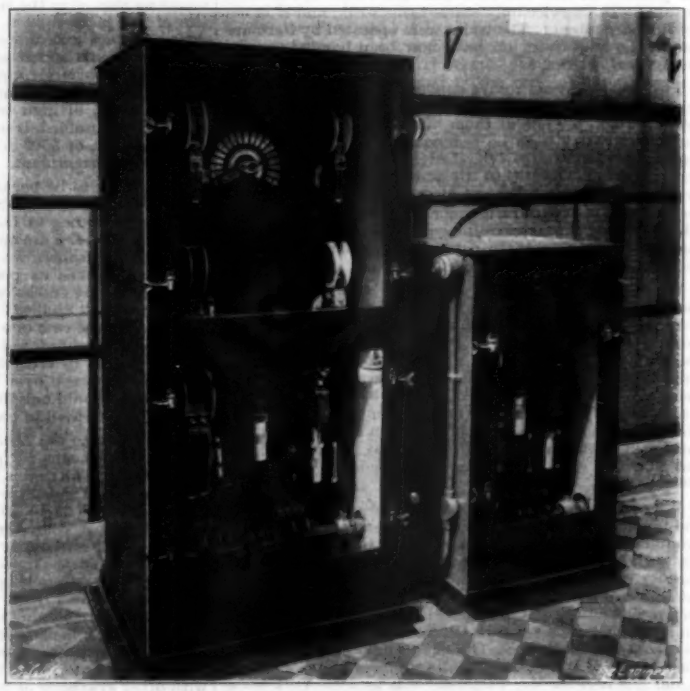


FIG. 18—CONTACTOR CONTROLLERS FOR 175 H.P. AND 12.5 H.P. D.C. MOTORS

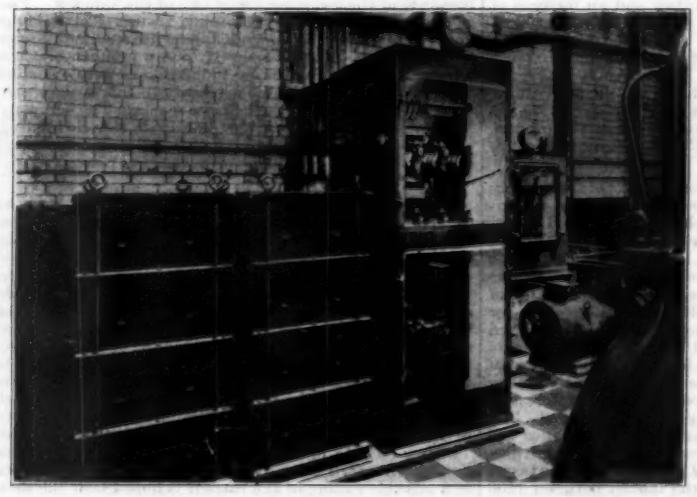


FIG. 19—CONTACTOR CONTROLLER FOR 1200 H.P. D.C. MOTOR

FIG. 20—DRAINAGE PUMP AND AUTOMATIC CONTROLLER

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The Metallurgist

THE AUGUST NUMBER OF THE MONTHLY METALLURGICAL SUPPLEMENT TO "THE ENGINEER" ACCOMPANIES THIS ISSUE.

THE ENGINEER.

AUGUST 27, 1926.

Hazards of the Submarine.

THE recent sinking of Submarine H 29 in a dockyard basin at Devonport, which caused the loss of six lives, has raised anew the question whether these vessels can be made reasonably safe for those who have to serve or work in them. It is true that the circumstances of the mishap to the H 29 were quite exceptional, and are not likely to recur; yet the comparative frequency of submarine disasters since the war has bred in the public mind a suspicion that there is something fundamentally defective in the design of modern underwater craft, or, alternatively, that insufficient attention has been paid to the problem of reducing the dangers incidental to their operation. The Admiralty's view is expressed in a Fleet Order issued two years ago, stating that the Board had decided "that the development of submarines has now reached such a stage that it is no longer practicable to adhere to the system of restricting service in them to volunteers." Although, it was added, volunteers would be called for as hitherto, and given preference in selection, officers would be appointed and ratings drafted for service in submarines as requirements might demand. This assumption that submarines are as safe as any other warships is not shared by lay opinion, nor can it be said to be supported by experience. The submarine is, in fact, an abnormal type of vessel, with a smaller reserve of buoyancy than that of any well-designed surface ship. Even when navigating above water it may be sunk outright as the result of damage which would not necessarily disable a surface vessel, and when that happens there is always a heavy death-roll. Last year, it will be recollected, the American boat S 51 was rammed by a steamship while cruising in surface trim and foundered immediately, with the loss of all but two of her complement. When a submarine meets with disaster under water her entire crew almost invariably perishes. In the post-war period four British and at least four foreign submarines have been lost with all hands. In face of this tragic record it is difficult to uphold the official view that no special risks menace the *personnel* of a submarine. It remains, then, to consider, first, whether these risks can be mitigated by modifying the form, structure, and integral equipment of such vessels; and, secondly, whether additional measures can be taken to preserve life in the event of disaster.

With regard to the first question, there is no reason to suppose that submarine design has reached finality. While it is true that a present-day boat does not differ materially in outward form from the earlier types, the internal structure has undergone important modification. Pressure bulkheads have been introduced, though expert opinion differs as to their utility as a safeguard against disaster. Multiple blowing and pumping stations are now provided, so that the tanks may be blown from two or more different positions in the boat. In the earlier submarines this essential gear could be operated from one compartment only, and if that compartment were flooded the boat was doomed. Air locks are also fitted, and they, in conjunction with the safety helmet, have a theoretical value as a life-saving factor. In practice, however, escape from a damaged submarine by means of the air lock is virtually impossible unless the boat is lying in shallow water. At any considerable depth the sudden variation of pressure would be likely to prove fatal to a man as soon as he entered the escape hatch, and the fact that he was wearing a safety helmet would avail him nothing. That is probably the reason why no record exists of any individual having escaped from a wrecked submarine in deep water. The problem of raising a disabled boat from the bed of the sea in time to save life is apparently insoluble, although a great many devices have been proposed to that end. The initial difficulty is to ascertain the position of the boat after her disappearance. If her people are still alive they may be able to make their presence known to the rescuers by various expedients, of which the following have been adopted in the British service:—(1) The Fessenden underwater signalling apparatus; (2) discharging tins containing messages; (3) discharging torpedoes with messages attacked; (4) discharging oil or air, or both. Other methods may be employed, but owing to the use for which they are primarily installed their nature is confidential. In some foreign navies it is customary to fit submarines with floats which, on being released, rise to the surface and give out a bright light or dense smoke, which serves to mark the position of the boat. Telephone buoys are also used in connection with this system. It is, however, a significant circumstance that none of the devices enumerated appears to have operated on the occasion of any recent submarine accident at home or abroad. Even if it were possible to establish early communication with a damaged boat, the safety of the crew would not necessarily be assured. A limited supply of air and nourishment might be conveyed to them through pipes, as was done when H.M. Submarine K 13 foundered in the Gareloch; but unless the boat could speedily be raised her people must perish. The extraordinary difficulty of raising a waterlogged submarine was exemplified in the case of H 29. Although that vessel sank within the precincts of a well-found dockyard, with her upper works barely under water, it took seventy-two hours of continuous labour to bring her to the surface. Moreover, the H 29 is a boat of only 440 tons, or less than half the displacement of our average submarines. If it took so long to raise this small vessel in shallow and sheltered water, with all the requisite gear close at hand, what hope can there be of promptly salving a submarine which has foundered at sea in deep water. More than nine months were occupied in lifting the American boat S 51, which was sunk in Long Island Sound last year, and it seemed at times as if the admirable salvage equipment of the American Navy would be unequal to the task. Submarines were formerly fitted with lifting eyes, to which hoisting tackle could be attached, but they appear to have been discarded in later boats. In any case, they were always of questionable value, for while the divers might succeed in getting the cables into position, the operation of lifting such an enormous weight would be impossible for any salvage vessel hitherto built, or which it would be feasible to build.

After reviewing all the circumstances, it is difficult to resist the conclusion that the dangers peculiar to submarine service admit of no real remedy, and are only to be overcome by abolishing the submarine itself. Unfortunately, that drastic solution has not yet found favour abroad, and Great Britain stands alone in her advocacy of it. Defenders of the submarine affect to be surprised at what they regard as the unjustifiable commotion that is raised whenever one of these boats comes to grief. In other fighting ships, they point out, the safety of the crew is not allowed to interfere with military efficiency, so why should an exception

be made in the case of submarines? No rational person has ever demanded that a battleship should carry enough boats to accommodate her entire crew, yet many people wish to see the submarine so burdened with safety devices as to reduce her combatant power to vanishing point. Such arguments, however, are altogether beside the mark. Accidents to surface men-of-war which involve the loss of the whole or the greater part of the crew are extremely rare. On the other hand, such accidents to submarines are of frequent occurrence, for the reasons already explained. It is precisely because the submarine is, in the words of the late chairman of Lloyd's, "a type of war machine which brings about the disasters of war in a time of profound peace," that its retention is viewed with abhorrence by many sober-minded people, not only in this country but abroad. We agree, however, that its abolition must come, if at all, through unanimous international decree. No individual State is in a position to throw away a weapon of undoubted potency as long as other States keep it in their armouries. But if the submarine is destined to survive, humanity must steel itself to endure the periodical tragedies which are inseparable from submarine navigation. The combined efforts of the scientist, the engineer, and the shipbuilder may eventually succeed in reducing the margin of risk, though we are by no means hopeful on that point. Sir Oliver Lodge has put the matter in a nutshell. "Submarines," he wrote, "represent misapplied ingenuity. They are not worthy of our naval traditions; they are sneaky as well as dangerous things. Moreover, any vessel containing air, not absolutely and perfectly sealed up, is unstable when submerged below the surface. It gets lighter when it goes up, heavier when it goes down. This is all wrong, and constitutes the chief danger in peace time."

The Combination of Errors.

The determination of the performance of prime movers is at once one of the most important and one of the most complex forms of testing which engineers have to carry out. Whether we regard the subject from the purely scientific or the purely commercial point of view or from an admixture of these two aspects, we cannot fail to be impressed by the fact that modern prime mover developments are all tending in the direction of increasing the difficulty and complexity of carrying out performance tests and by the additional fact that the means and devices at our disposal for conducting such tests are, in spite of the apparent progress registered in recent years, still very far from being perfect. While it is true that the fuel consumption of a heavy oil engine can be measured in a relatively simple manner with considerable assurance of accuracy, the advantage so gained is more than set off by the well-known difficulties of indicating internal combustion engines in a satisfactory manner. The input to a steam turbine cannot be indicated, and can only be deduced from a measurement of the steam consumption; its output is frequently beyond the capacity of any form of absorption dynamometer, and can only be arrived at by means of a torsionmeter or some other type of transmission instrument, or by measuring the output and efficiency of an electrical generator coupled to the turbine. Improvements there undoubtedly have been in indicators, brakes, calorimeters and other items of testing equipment, but even now we would have just cause for satisfaction were we certain that no measurement of the many involved in a prime mover performance test had an error exceeding 5 per cent. Such a lack of assurance as to the real output and efficiency of the engines we build is somewhat humiliating from the scientific standpoint; from the commercial, it may be even more regrettable, for a 5 per cent. variation in, say, the efficiency of a prime mover may quite well determine its acceptance or rejection by a would-be purchaser. Unsatisfactory as the position is, it is at times undoubtedly made worse by a failure on the part of experimenters to recognise certain fundamental facts governing the treatment of inaccuracies and errors of observation. In general, too much attention is paid to the elimination of errors and too little to what may be called their control, without elimination.

In many instances experimenters in their treatment of this matter proceed on the basis of the doctrine vaguely designated as the accumulation of small errors. In the belief that the final error will be the sum of the errors in the individual items entering into the final account, they seek, at considerable pains, to make each of the individual errors as small as possible. By so doing, they may at times actually increase the final error. The absolute magnitude of each separate error is frequently of little importance. So far as the final result is concerned, it is, in general, much more profitable to pay attention to the relative magnitudes and signs of the errors as a series. The figure assigned to the mechanical efficiency of a prime mover will not be affected in the slightest degree by a 50 per cent. error in the measurement of the brake horse-power, provided we make a similar percentage error in the indicated horse-power and provided both errors represent underestimations or both over-estimations of the real powers. Equality in the magnitude and sign of the errors in the factors of a ratio leaves the value of the ratio unaffected by the errors, no matter how great their magnitude may be. If the indicator results in an error of 5 per cent. in the estimation of the indicated horse-power, it is definitely wrong to endeavour to measure the brake horse-power without error. The correct procedure, so far as the determination of the mechanical efficiency is concerned, is to incur an equal error of the same sign in the dynamometer figure. Even although the mark is overshot and an error of 10 per cent. is incurred in the brake horse-power, the error in the mechanical efficiency will be numerically no greater than it would be if the brake horse-power were determined with mathematical accuracy. When we have to deal with the product of two experimental factors instead of their ratio, the same principle holds good in an altered form. If one of the factors is known to involve an error, our endeavour should be to induce an error in the other of opposite sign and of somewhat greater numerical magnitude. For example, in the measurement of the heat units supplied to an engine, an over-estimate of the weight of fuel delivered per minute amounting to, say, 5 per cent., will be without effect if the calorific value of the fuel is underestimated by 5.26 per cent. The determination of the thermal efficiency of an engine involves a multiplicity of experimental factors which, however, may be reduced to four, namely, Joule's equivalent and the indicated—or brake—horse-power, the quantity of fuel consumed per minute, and its calorific value. Each of these factors may be exact, high or low, but it is quite erroneous to believe that an exact value of the thermal efficiency can only be obtained if all four factors are without error or discrepancy. On the contrary, of the eighty-one possible combinations of error which may arise, twenty-seven are conducive to the attainment of an accurate result. If we eliminate Joule's equivalent from the argument on the ground that it is known to a high degree of accuracy, the three remaining factors afford twenty-seven possible combinations of error. Of these combinations, nine are conducive to accuracy in the final result. If but two factors are involved, and if each may be exact, high or low, then whether they are used to form a ratio or a product, nine possible combinations of error exist, of which three are conducive to an accurate result. It is important that the meaning of these figures should not be misunderstood. They do not mean that if two, three or four experimental figures, obtained with little attention to accuracy, are combined, the chances of reaching an accurate result are in the ratio of one to two. Would that it were so! All that the figures given can be held to imply is that on the average two out of every three of the combinations will definitely reflect, and even may exaggerate, the errors of the individual factors, while in the third the effect of the individual errors will be lessened, and, it may be—if the relative magnitudes of the errors are appropriate—completely eliminated.

In many instances it is possible to assign an approximate figure for the probable error in an experimentally determined quantity. In a few cases it is found possible to state that the observed value is more likely to be high than low or low than high. In the great majority of examples, however, we have to rest content with a statement of the magnitude of the probable error without any expression of opinion as to its sign. It is to be regretted that experimenters should expend much time and pains in endeavouring to conform the errors of their observations to some set standard of magnitude. The labour so spent would in very many instances be more profitably devoted to securing uniformity among the errors as regards their relative magnitude and sign without attending too closely to the absolute magnitude. If the brake and indicated horse-powers of an engine are determined with an error of $\pm$ 5 per cent., the mechanical efficiency may be anything from about 10 per cent. above to 10 per cent. below the alleged figure. If, on the other hand, the brake horse-power is underestimated by such a gross amount as 50 per cent., and the indicated horse-power is also underestimated by a relatively great amount, say, 55 per cent., the alleged mechanical efficiency will be but 3 per cent. in error on the high side. It is far from our intention or desire to do anything in the least likely to encourage experimenters to relax the care with which they make their observations. We do not recommend them to incur 50 per cent. errors if they find it possible to work to 5 per cent. Our object will be served if we succeed in calling attention to the commonly ignored fact that if the figures collected are to be combined as ratios or products, and are not individually of intrinsic importance, uniformity of error may readily be more conducive to accuracy in the final result than low absolute errors.

"Ghost" Lines in Steel Forgings.

By Dr. W. H. HATFIELD, Chairman of the Steel Ingots Committee of the Iron and Steel Institute.

The "ghost" line phenomenon, to which the whole of "The Metallurgist" issued with this number of The Engineer is devoted, cannot be considered apart from the general subject of the heterogeneity of the original steel ingots. Realising the importance of a complete investigation of the question, particularly as regards the influence of the increasing size of ingot, an Iron and Steel Institute Committee was formed in 1924, and has since carried on its work with the complete support of the steel industry. The constitution of the Committee was as follows:—

Mr. T. P. Colclough (The Park Gate Iron and Steel Company, Ltd.).
Mr. W. J. Dawson (Hadfields, Ltd.).
Mr. J. H. S. Dickenson (Vickers Ltd.), Vice-chairman.
Mr. A. P. Hague (Cammell Laird and Co., Ltd.).
Dr. W. H. Hatfield (The Brown-Firth Research Laboratories), Chairman.
Mr. E. F. Law (Sir W. G. Armstrong, Whitworth and Co., Ltd.).
Mr. S. A. Main (Hadfields, Ltd.).
Mr. T. M. Service (Wm. Beardmore and Co., Ltd.).
Mr. J. H. Whiteley (The South Durham Steel and Iron Co., Ltd.).
Mr. G. C. Lloyd (Secretary, The Iron and Steel Institute).

The first report of the Committee was presented to the June meeting of the Iron and Steel Institute, and was fully discussed. The writer would draw attention to certain features of the report which bear on the subject of "ghost" lines. As a perusal of the report will indicate, ingots were studied ranging in weight from 15 cwt. to 172 tons each, all representative of good contemporary practice.

"Although ordinary commercial ingots cast in chill moulds, if sectioned longitudinally along the axes and examined by various methods, disclose considerable structural variation, owing to differences in size, shape, manner of casting and composition, yet they all possess certain common characteristics, which are readily observable. Their similarity in regard to these technically important structural features is due mainly to the fact that the molten steel when poured into the mould requires a period of time for complete solidification. Freezing commences at the outer surface and proceeds by selective crystallisation, with the result that the unavoidable phenomena of shrinkage and segregation must always proceed on similar lines, and lead in varying degree to similar effects in all cases."

"The metallographic study of a longitudinal section of any ingot made from steel which has been refined or treated so as to solidify without the formation of blow-holes reveals the following phenomena:

"(1) A very thin extreme outer skin of ill-defined crystalline structure is generally observed—*i.e.*, true chill crystals.

"(2) From the inner surface of this very thin layer a growth of columnar crystals appears, extending inwards (zone 1); the thickness of this layer will depend upon the temperature of the liquid steel, rate of teeming, the temperature, thickness, and nature of the mould, the size of the ingot, and composition of the steel.

"(3) Proceeding towards the centre of the ingot, it will be found that beyond the zone of columnar crystals lies a region richer in segregates, the segregate usually occurring in the form of spheroids or thin strings. This zone of segregation (zone 2) is of annular form, its inner boundary having roughly the form of a truncated cone or pyramid, according to the shape of the ingot.

"(4) Sulphur prints and etchings show that inwards from zone 2 there is a central zone (zone 3), in which the crystals may cease to possess the hitherto well-marked columnar form. In the lower half of this zone the steel is lower in carbon, sulphur and phosphorus than the original liquid steel—the

lower central axis is indeed the purest part of the ingot. In the upper half of the ingot this central zone approaches the average composition of the steel, but in many cases local segregation appears within it, assuming frequently a roughly V-shaped form.

"(5) At the extreme upper end of zone 3 there is a region of segregation.

"(6) The axial portion of the ingot is always rather unsound, and, except in the lower part, seldom quite free from segregation.

"(7) Unsoundness is sometimes found, though to a less degree, in vertical planes radiating to the corners of the ingot, and in inclined planes from the edges of the base of the ingot.

"Besides presenting studies of longitudinal sections along the axis, the data have been amplified by the addition of a sulphur print showing a section cut transversely midway in the length of a bloom, 40in. in diameter, produced from an ingot weighing 32 tons 17 cwt. 2 qr., and measuring 49in. at the top and 45in. at the bottom across the flats. The heterogeneity disclosed in this cross-section should be compared with that shown in the longitudinal sections."

In amplification and attempted explanation of Clause 3, the Committee in a later section of the report make the following observations:—

"The columnar region having formed, the interesting position is reached at which marked heterogeneity begins to be apparent. The liquid steel existing in proximity to the already frozen columnar region is apparently richer in carbon, sulphur and phosphorus than the original liquid steel. The higher concentration of the elements mentioned in this zone appears to persist in contrast to the average composition of the remaining body of liquid steel, and continues to do so in some degree until solidification of the ingot is complete. As a result of the reactions in the steel-making furnace, there exist to a greater or less degree oxides dispersed through the liquid steel in a more or less colloidal form. 'Manganese sulphide,'* which is held to be insoluble in liquid steel, is also dispersed in a similar manner, and it is an interesting and demonstrable fact that, in the region of high concentration adjoining the surface of the columnar growth, the sulphides, as one would expect, and the oxides also, as suggested by some, appear to segregate. As the growth of the columnar crystals proceeds, the degree of the concentration of the oxides in the adjoining liquid steel naturally increases, and zones of segregate become emphasised, and the non-metallic matter coalesces. Some of the segregate and non-metallic matter is entangled in the tips of and between the growing crystals, and some apparently rises by virtue of lower density. When the ascending segregates are impeded by the growing crystals, they tend to elongate and form typical string-like formations of segregate known as 'ghost' lines. If this description be correct, then the position of the extent of the first zone of segregation will depend upon the depth to which the early columnar crystals are produced, which indeed would seem to be the case."

It will be clear from the foregoing that the heterogeneity existing in ingots is being intensively studied in the industry, but that it is the normal result of the selective freezing occurring during the solidification of the ingot. The "ghost" lines observed in forgings are undoubtedly due to the persistence of segregation effects which could have been observed in the ingot state.

The Committee is fortunate in the facilities for investigation given to it by a number of large firms in the industry, and is proceeding further with its work.

In conclusion, attention might be drawn to the valuable bibliography prepared by Mr. Lloyd and his staff of all the important literature on the subject published since 1903, which will be found as the last section of the report on the Heterogeneity of Steel Ingots, *Journal* of the Iron and Steel Institute, Vol. I, 1926.

* MnS is here used as an empirical description covering all those inclusions which are largely composed of MnS.

Literature.

Lokomotivversuche in Russland (*Locomotive Tests in Russia*). By Professor G. Lomonossoff. German translation by Dr. E. Mrongovius. Berlin: V.D.I. Verlag. 1926. Price RM. 42.

Professor Lomonossoff, who is already well known to many railway engineers on the Continent from his previous publications dealing with questions concerning locomotives and tractive power on railways, has, with the exception, we believe, of his record of the evolution of the Diesel locomotive, or, as he more properly calls it, the thermolocomotive, published the results of most of his researches in his mother tongue, the Russian language.

His work on the thermolocomotive was, however, translated into German by Dr. E. Mrongovius and published by the V.D.I. in Berlin (the Society of German Engineers) towards the end of 1924. As there can be no doubt that the number of English railwaymen who can read Russian is very limited, he therefore did the technical world signal service in placing his very complete and frank account of the first thermolocomotive, which has been put to work under everyday conditions of heavy railway service, at the disposal of a much larger circle of readers. He has now published through the press of the same society a German translation, also by Dr. Mrongovius, of his work describing the methods employed and the results obtained while testing a very large number of different types of locomotives in use on the Russian railways. These tests were carried out between the years 1898 and 1923, so that the experience of over a quarter of a century is the foundation on which his conclusions are based. If we add that Professor Lomonossoff is not only an acknowledged theoretician, but also possessed of unusual practical attainments which enable him to get "the last ounce" out of an engine by his exceptionally skilled driving under the most trying conditions, we believe that this will be an additional proof that what he has to tell his readers is worthy of serious consideration.

The book before us is a sturdy volume of 330 pages, 9in. by 12in., with no less than 647 illustrations, mostly graphs plotted from the various tests, and also three plates. It is therefore a work requiring considerable attention to enable the reader to grasp its contents. Its importance is attested by the fact that Dr. Gustav Hammer, formerly president of the State Railway Central Office in Berlin and now Director of the "Reichsbahn," appreciated its value so much that he not only induced the author to have it translated into German, but has himself written a preface to it. He considers it an important addition to our knowledge of the subject treated and remarks that it is at once apparent that the Russian railways did not object to spending considerable sums and an unusual amount of labour in order to find out what engines were most suitable for their purpose, and that by practically utilising the results of the tests very important economies can be assured. He states that a saving of 1 per cent. in the average amount of fuel consumed by the Reichsbahn locomotives would mean a reduction of the coal bill by at least £100,000 yearly.* There is thus a real *raison d'être* for the study of the book.

The work is divided into five sections, dealing with: (1) The aim of the tests and the methods employed; (2) the types of engine tested; (3) detailed results obtained with various classes of 0–10–0 engines; (4) the more important results obtained with other types; (5) the application of the results obtained to everyday practice.

It must here be remarked that the 0–10–0 type was selected for specially detailed treatment because it is the most prevalent in Russia at the present time, no fewer than 1200 having been supplied by German and Swedish firms since the war, and also because this class is of special interest to the German-speaking railway world on account of the large number of locomotives of a similar type at work in Germany and Austria.

The first tests were carried out in 1898 on 0–8–0 engines, running on the Charkoff-Nicolaieff line, when the main features of the system employed during the following years were worked out. Then followed the 2–8–0, 2–6–0, 4–6–0 types, later the 0–6–0 + 0–6–0 Mallet engines, and lastly the 2–6–2 type. The reasons leading up to the introduction of these classes are succinctly given and are often interesting. The 2–6–2 engine is the one which to-day is most in evidence for passenger work, but it is not at its best when the speed exceeds 50 miles per hour. When the demand for more powerful locomotives arises, Russian engineers are in a position which we from a technical point of view cannot but envy. Even though their axle loads are comparatively low, they have the compensation of a 5ft. gauge and have already boilers with a centre line 10ft. 6in. and a chimney height of 17ft. above the rails! Such are the advantages of a generous loading gauge.

The report of the tests of the 0–10–0 type occupy no less than eighty-three pages, or one-quarter of the contents of the work, and are given in great detail. The tests were carried out in the years 1915 to 1924 on engines of successive series of this class, so that the value of the modifications which have been introduced as a result of the experience gained has been also duly investigated. Various types of oil-burning apparatus were used on the engines examined, as well as various grades of Russian coal. One of the latest locomotives was also run on the testing plant ordered by the Soviet Government from the Hohenzollern Locomotive Works in Düsseldorf (The Engineer, November 14th, 1924). Such tests have a great value, as they can be carried out without being compelled to respect the exigencies of keeping the line clear for ordinary traffic and leave the staff a free hand as regards time and speed. On the testing plant the tractive power can be adjusted to that of a train of desired weight on a given gradient and the latter can be made of unlimited length. But Professor Lomonossoff is unquestionably right in preferring after all the trials run on the track itself, for, as he says, *e.g.*, in test plant trials, the draught due to the train speed is wanting and the vibration in passing over the rails also, and these have their effect on certain functions of the locomotive when hauling a real train.

The concluding chapters of this section are devoted to the thermal balance sheet of the trials and the author closes with the remark that the Diesel locomotive ought to replace the steam locomotive.

Space will not permit us to refer in detail to the contents of Section 4, but we note with interest that Professor Lomonossoff sums up the much-debated question of compounding *with* superheating in the following words:—

"(*a*) At slow speeds the advantage in compounding is not to be gainsaid.

"(*b*) The value of superheating increases with the speed, while the value of compounding decreases.

"(*c*) With a high degree of superheat the advantage increases with the speed both in single and double-expansion engines.

"(*d*) Consequently compounding with superheating is advantageous for low speeds, but whether this is worth while for high speeds cannot be said at present, as the question has still to be cleared up.

"(*e*) Two-cylinder compounds have a smaller factor of adhesion and also a lower boiler efficiency.

"(*f*) In Mallet locomotives the losses in the receiver are too great and the adhesion factor is also too low."

Section 4 closes with a *résumé* of the results of the tests and the author draws his conclusions as to the most suitable types of engine for the conditions prevailing to-day in Russia. We learn that a 4–8–0 locomotive for a tractive power of 12 tons at a speed of 19 miles per hour is being studied, and he recommends that the three following variations, (*a*) three cylinders all of same size, (*b*) three uniflow cylinders, (*c*) four-cylinder compound should be tried. All three should have high-grade superheat and feed-water heaters, and also a maximum speed 63 miles per hour.

Coming now to Section 5, we find here perhaps the most valuable of all the contents of the book, viz., the practical application of the results obtained exemplified by typical cases. We quote one or two taken at random to show what is possible:—

(1) Given a local passenger train with a weight of 425 tons, running from P to K, the carriages being all of the double-bogie type. The locomotive is a certain class of 4–6–0, burning naphtha. What is the shortest running time that must be allowed?

(2) To find the naphtha and water consumption for an engine of a given class when hauling a fast train of 460 tons weight from S to T, stopping only at L. Other stations must only be passed at a reduced speed of 30 miles, while at two given bridges the speed must be further reduced.

(3) Can time be kept with the above train if an engine of another given class is used which burns a certain grade of coal?

(4) Must the tender in this case be refilled *en route*?

(5) What is the effect of raising the speed of a goods train from 20 to 30 miles per hour, the engine being a 0–8–0 of Class 0 and the weight of train 870 tons?

We are, of course, aware that such problems can be solved with more or less accuracy in practical railway work by interpolating existing proved results or by various empirical rules. We believe, however, that in the present work a solution based on experiments carried out in a scientific manner has been presented for the first time to the railway profession.

In conclusion, we may point out some drawbacks which we have noticed, but only as a suggestion that should a second or perhaps even an English edition be called for, they may be taken into consideration. The author himself in the preface calls attention to the fact that the original Russian blocks have been used for the very numerous diagrams, and as these often bear Russian letters and terms, it has been necessary to give these again in the text. This no doubt makes it more difficult than it otherwise would be to follow up the train of thought of the author. The various types of engine are expressed in terms of the axle arrangement, which to English eyes seems strange, as we use the number of wheels for the same purpose. Where we accordingly read of a "2–3–0" engine we must multiply the figures by 2 to get the English equivalent, or "4–6–0."

Although the table of contents is helpful, yet we think that the addition of an index, even if of summary nature, would have made the book more handy for everyday consultation, although we are aware that it is not easy to compile an index for a work of this nature.

Numerous footnotes give the sources of information drawn upon, and naturally these are mostly of Russian origin, being frequently previous works of the author. American, Austrian, French, German, and Italian authorities are also quoted, but we have not noticed an English name. We are almost afraid that the reason is that, in the classic land of locomotive building, original research in these matters has not during the last decades received that amount of attention which is its due. Considering the position in which our railways are, it seems a moot question whether it would not be worth the while of our leading companies to consider this matter more closely. We do not doubt that in this respect the continental lines will give the book the attention of which it is worthy.

Professor Lomonossoff is, as we have hinted, generous in his use of graphical solutions and diagrams; the text is crisp and concise. He quotes Laplace, "La theorie n'est que le bon sens confirmé par le calcul," and is himself the best example of the truth of that saying.

* According to returns recently published, the corresponding figure for the L.M.S. in 1925 would be about £60,000.

Models and Analogies for Demonstrating Electrical Principles.

No. III.*

It has been shown by Professors Ayrton and Perry and by Dr. J. Hopkinson and others, that the behaviour of dielectrics with regard to what are termed their "residual charge" effects is analogous to that of wires subjected to mechanical stress. If an iron wire be suspended by one end and a weight applied at the other, it is found that, if the application of the weight has only lasted for a fraction of a second, the wire assumes its original length immediately the weight is taken off, provided the stress has not exceeded a certain limit. If the application of the weight be continued for a considerable time, it is found that the wire does not assume its original length immediately the load is removed. A small elongation still remains which slowly disappears, the wire very gradually decreasing in length to its original dimensions. In the case of the condenser, if the time of charge is very short, the whole of the charge disappears almost immediately on the condenser plates being short-circuited. If, however, the charging pressure be kept on for a considerable time, there is first a discharge which takes place immediately on short-circuiting the condenser, and that is followed by a slow giving-up of residual charge, causing a continually decreasing current through the short-circuiting wire. The stress on the wire in the mechanical experiment is analogous to the electromotive force in the electrical experiment. The charge of the condenser corresponds to the elongation of the wire. The rate of variation of the charge, *i.e.*, the charging or discharging current, is therefore analogous to the rate of change of displacement of the movable end of the wire, that is, the velocity of that end of the wire.

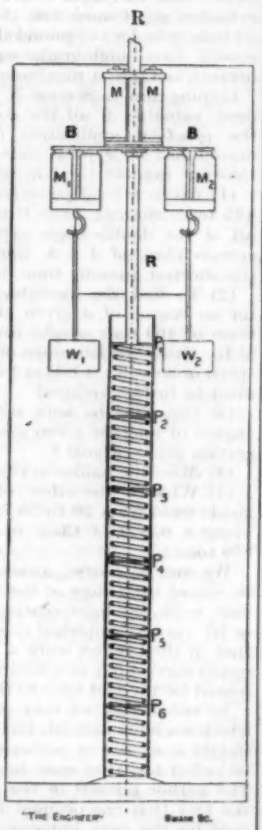


FIG. 24—MODEL FOR DEMONSTRATING THE BEHAVIOUR OF DIELECTRICS

A simple twisted wire is not, however, able to imitate all dielectric effects. Hence an endeavour has been made by Professor Fleming and Mr. A. W. Ashton† to follow up this analogy more completely, and it has resulted in the construction of a model from which, by the application of weights, curves of variation of velocity with time which are strikingly similar to the curves of current variation with time given by condensers when charged and discharged can be obtained. A simple form of the model can be made by taking two short lengths of spiral spring S_1 S_2, and a metal cylinder slightly larger than the springs in diameter. To each spring is attached a piston P_1 P_2, which just slides in the cylinder. The two springs with pistons attached are placed one above the other in the cylinder, which is then filled with oil. The top piston P_1 must have holes drilled in it sufficiently large to allow the piston to slide very easily through the oil. Let W be a weight just sufficient to compress S_1 and S_2 to half their original length. If the weight be applied momentarily, compression is produced in the upper spring S_1, but provided the weight is immediately removed, the compression of S_2 is infinitesimal. If, however, the weight be kept on, the upper spring S_1 is soon compressed to its full extent, but the compression of S_2 proceeds very slowly and with decreasing velocity. If the weight is removed, S_1 regains its original length almost immediately, but the piston P_2 moves up to its original position very slowly. The variation of the displacement of P_1 is therefore very similar to the variation in the quantities absorbed and discharged by a condenser when both the charging and discharging are continued for a considerable time.

A simple apparatus such as that described above would draw curves somewhat similar to those obtained from the model about to be described; but it is evident that these curves would not completely represent the behaviour of a condenser. For the motion of P_1 after the first few seconds of discharge is simply a copy of the motion of P_2; also the motion of P_2 at any instant depends solely on the amount of compression in S_2 at that instant. Therefore it follows that, the springs having been compressed to a given extent and released, the motion of P_2, and therefore of P_1 also after the first few seconds, depends only on the amount of the displacement, and not on the manner in which that displacement was produced. Thus it will be seen that only one velocity curve could be obtained from this model, and the equation of the curve would not vary with the time of charge. It has been found that if as many as six pistons and springs are used, the curves drawn by the model may be represented, at least approximately, by equations which are similar in form to those obtained by experiments on dielectrics. In the model to be described, the springs are 2¼in. long, and are made of No. 12 S.W.G. brass wire, with a pitch of about 3in. To each spring is fixed a brass disc which forms the corresponding piston. The piston P_6—Fig. 24—fits fairly tightly in the cylinder, and has no hole drilled in it. The second piston has no hole bored in it, but fits slacker in the cylinder than the first. The third piston has one hole $^3/_{32}$in. in diameter, and each succeeding piston has a greater area cut away, the top piston having just sufficient metal left to make the spring come to rest without vibration after being compressed. The cylinder is filled with a mixture of machine oil and vaseline. To the top piston is attached a brass tube to which is fastened a compound cross-bar B, which is built up of two pieces of soft iron separated by a piece of sheet brass. The upper part of the cross-bar forms the armature of an electro-magnet M the yoke of which has a hole drilled in it to form a guide for the rod R. Two electro-magnets M_1 and M_2, carrying weights W_1 and W_2, can be attached to the lower plate of the cross-bar, and can be instantaneously detached by breaking the circuit. The upper magnet M, by its attraction of the upper plate of the cross-bar, keeps the top piston in its zero position. If the magnets M_1 and M_2 are attached to the bar as shown, on breaking the circuit of M the cross-bar moves downward under the action of the weights, and this corresponds to the charging of the condenser. If the circuit of M_1 and M_2 be then broken, the cross-bar moves under the action of the springs alone, and its motion corresponds to the discharge of the condenser. In order to draw diagrams of the motion, a pencil which runs in a guide is attached to the cross-bar. This pencil moves over the surface of a clock-work-driven recording drum, which runs in bearings attached to the back of the teak framework of the model. It may be asked, in what respect does the action of this model differ from that of a simple twisted wire in illustrating dielectric effects? The answer is that experiment has shown that although the current flowing out of a charged condenser is a simple power-function of the time, the exponent varies with the time of charging. In the case of the simple twisted wire, whether the wire be twisted quickly or slowly, the twist per unit length of the wire is approximately the same. In the case of the model described, however, the effect of the compression makes itself felt first on the top piston, and hence the amount of total compression depends not only upon the compressing force, but also upon the time during which this acts, and this compression is propagated gradually down the chain of pistons. In this respect the model imitates closely the electrical behaviour of dielectrics, such as india-rubber, when subjected for various times to different electromotive forces.

Professor Fleming has also described in a paper read before the Physical Society of London‡ a model for illustrating the propagation of a periodic electric current in a telephone cable, and has given a simple theory of its operation. The object is to explain the propagation of a periodic or alternating electric current in a telegraph or telephone cable having resistance, inductance capacity, and leakage or insulation conductance of a certain value per mile or knot. The periodic change with time and distance is represented by the model shown in Fig. 25.

On a long steel axle A A^1 excentric pulleys E_1, E_2, E_3, &c., are fastened, and the excentricities of these wheels decrease in geometric progression. Each excentric is set in phase backward behind its preceding neighbour by an equal angle. The wheels are embraced by cords C_1, C_2, C_3, &c., attached to balls or blocks of metal P_1, P_2, P_3, sliding on vertical rods R_1, R_2, R_3, &c., placed below each excentric wheel, the cords all being of the same length. When the axle carrying all the excentrics is revolved by a handle W, the blocks P_1, &c., rise and fall with a nearly simple harmonic motion, and at any instant all the blocks are situated on a sinuous curve of constantly decreasing amplitude. As the excentric axle revolves the motion of the balls will depict the progression of a wave of potential along a cable having capacity inductance, resistance and leakage.

In a later paper read before the Physical Society of London§ Professor Fleming described an apparatus for the production of vibrations on strings loaded or unloaded for illustrating the properties of loaded or unloaded telephone cables. This method is an improvement on that of Melde, in which transverse vibrations are created on a string attached to the prong of a tuning fork. Melde's method has the disadvantage that it is not possible to put great tension on the string without stopping the fork, or to use very heavy or loaded strings without using forks of great size. Moreover, the frequency cannot be varied except by changing the fork. In Professor Fleming's method the vibrations are produced on a string by attaching one end to the shaft of a small continuous-current motor of about ¼ horse-power. The motor has on one end of its shaft a mechanism for counting revolutions, and on the other end a disc which has a crank pin inserted in its outer face, and to this pin a light crank shaft is attached and connected at its outer extremity with a rocking lever. The string is fastened to a hook on the crank shaft near to the crank pin, whilst the other end of the string is attached to a fixed point which can be moved by means of a screw. In some cases a spring balance is interposed to measure the tension.

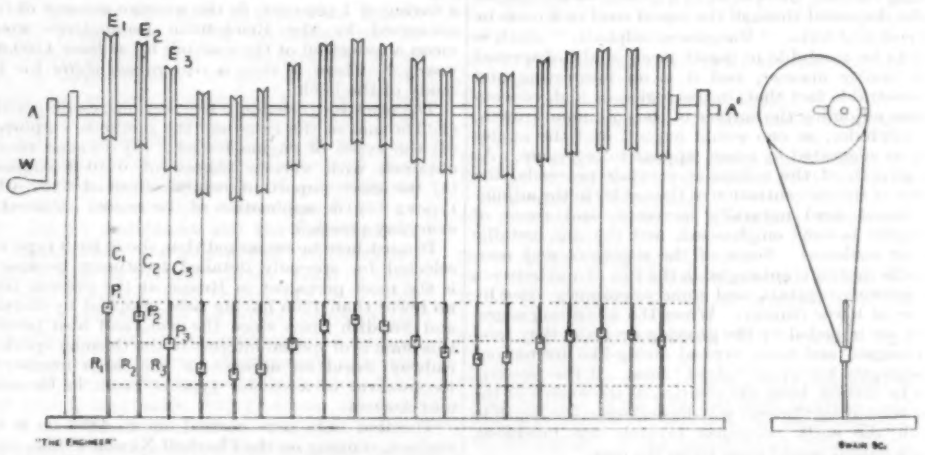


FIG. 25—MODEL FOR DEMONSTRATING THE PROPAGATION OF A PERIODIC CURRENT IN A TELEPHONE CABLE

When the motor is started the string has a circular motion given to its end which is equivalent to two simple harmonic motions at right angles to each other. If the tension be correctly adjusted the string then vibrates in sections, and the number of sections can be adjusted by altering the tension. The distance from node to node can then easily be measured and the frequency determined from the speed of the motor. In this way the velocity of the wave is measured, and can be compared with the velocity determined by taking the square root of the quotient of the tension by the linear density of the string. At the time the paper was read tables were exhibited showing the velocity of the wave motion on strings of various kinds confirming the known laws of string vibrations.

The method is particularly useful in studying the properties of loaded strings. Strings made of flexible cotton cord can be loaded with glass or wooden beads and set in vibration. In this manner it can be shown experimentally that when the wave length on the string extends over a distance of more than eight or ten loads the string vibrates as if the loading matter were uniformly distributed, but the string cannot propagate vibrations when the half-wave length approaches equality to the distance between two loads. It is also possible to show by this apparatus the reflection of a wave at a load placed at any point on the string, and also that this reflection is reduced by tapering off the loading.

It is thus possible to imitate with the loaded vibrating string all the phenomena of inductive loading in telephone cables on the Pupin system. The theory of the vibrations of a loaded string has been studied by many mathematicians—for example, by

* No. II. appeared August 20th.

† See the "Proceedings" of the Physical Society of London, August, 1901.

‡ The "Proceedings" of the Physical Society of London, Vol. XIX.

§ The "Proceedings" of the Physical Society of London, Vol. XXVI., Part I.

Lagrange, Lord Rayleigh, Professor P. G. Tait, and a very interesting paper was published on the subject by Mr. Charles Godfrey in the *Philosophical Magazine* for April, 1898. This method of causing a string to vibrate by a motor affords a simple method of demonstrating all the laws of vibrating strings to a class, and can also be employed to show experimentally the results of loading telephone cables in various ways and the reflections that occur when cables with different constants are connected in series.

The best arrangement is shown in Fig. 26. The pulley or disc P is attached to the shaft of a small continuous-current motor, and on this disc there is a crank pin K at a distance of about 0·5in. from the centre. To this pin is attached a light crank shaft C, which is connected at its outer end to a rocking lever L. A small hook H is attached to the crank shaft quite close to the crank pin and another at the far end, close

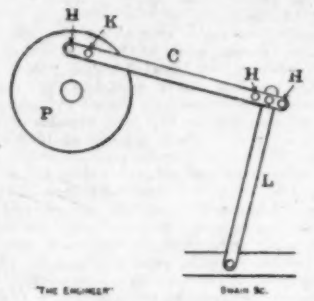


FIG. 26—METHOD OF PRODUCING STRING VIBRATIONS

to the junction with the top end of the rocking lever. On the other end of the motor shaft there is an endless screw gearing with a toothed wheel, the latter carrying a pin on its face, which strikes once every revolution against a small piece of clock spring, and this mechanism serves to count the speed of the motor. The time taken for 20 or 1000 revolutions of the wheel can be noted by a stop watch, and knowing the gear ratio the speed of the motor can be obtained. The hook on the crank shaft near the crank pin describes a circular path in space, whilst the hook at the far end of the crank moves to and fro with an approximately simple harmonic motion.

If a long stretched flexible cord be fastened to either hook, means are obtained of impressing upon the end of the cord simple harmonic motions, either (1) in the direction of its length, or (2) transverse to its length, or (3) a circular motion equivalent to the combination of two simple harmonic motions differing 90 deg. in phase, each taking place in a direction at right angles to the direction of the stretched cord. Any desired tension can be put on the cord in the manner described, and it is also possible to measure the tension by means of a spring balance inserted between the end of the cord and the terminal pin.

If one end of the cord be attached to the hook nearest the crank pin of the motor with the string

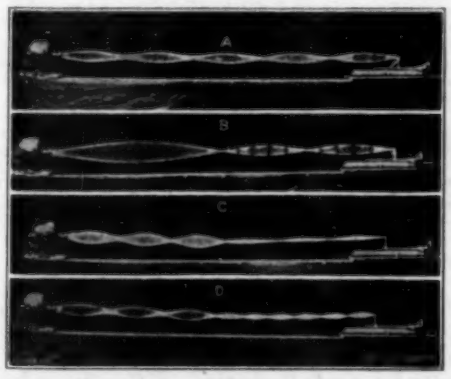


FIG. 27—VIBRATING STRING WAVES

stretched parallel to the axis of the motor, and a certain tension be applied at the other end of the string, when the motor is set into operation vibrations are propagated along the cord such that each part of the cord describes a circular motion.

By properly adjusting the tension on the cord and the speed of the motor, oscillations may be set up on the cord which are the resultant of two simple transverse harmonic motions at right angles and differing 90 deg. in phase. On account of the persistence of vision the cord appears spindle shaped, and if the tension be adjusted, it is possible to make the cord vibrate in a single loop, or in two, three, &c., loops, in up to a dozen or more segments, corresponding to the various harmonics of the fundamental mode of vibration of the cord, as shown in Fig. 27. With the aid of the slide rest arrangement at the end of the cord, remote from the driving motor, the tension can be accurately adjusted so as to produce any required number of sections and to keep them steady; whilst by sending a beam of light from an arc lamp along the cord, these stationary vibrations can be rendered visible to large audiences.

It is possible easily to measure the half-wave lengths or distances from node to node by a beam compass, and having also the means of measuring the speed of the motor, the velocity with which a wave motion of any wave length travels along the cord can be calculated. The cord can be loaded by fixing glass beads or cork or wooden balls at equal intervals, and the possible modes of vibration on the loaded coil can be studied.

At A in Fig. 27 are shown standing waves on an unloaded string. If glass beads be placed at regular intervals on one-half of a string, 4 m. long, and the extremity of the unloaded half be attached to a motor wheel, and a tension be applied to the other end, then standing waves will be produced on both parts, as shown at B in Fig. 27. These standing waves have, however, different lengths on the two parts and vary inversely as the square roots of the mean cord densities. The amplitude of the waves on the unloaded half of the cord was much greater than that of the waves on the loaded cord, thus showing the loss of amplitude on reflection. The same effect can be shown better by employing a cord one-half of which is single and the other half made of four similar cords in parallel. When a string of this kind was set into vibration, the waves on the four-fold part were half the length of those on the single part, as shown at D in Fig. 27. When the tension was decreased slightly, so as to lower the velocity and decrease the length of the waves, a point was soon reached at which, whilst standing waves were produced on the unloaded half of the cord, no waves were produced on the loaded half. This experiment proves that there is an inferior limit to the possible wave length and a superior limit to the possible frequency of the vibrations which can be produced on the loaded string, exactly as predicted by theory.

The same reflection of the waves and loss of amplitude on passing a junction between two cords of different mass per unit of length can be shown by joining two cords of equal length, one a plain cotton

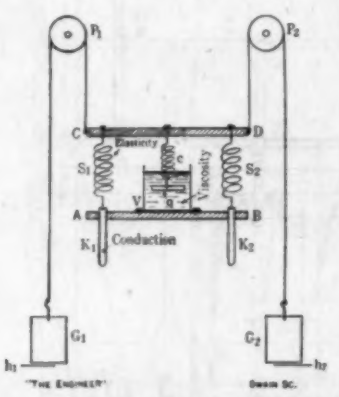


FIG 28—IMPERFECT DIELECTRIC ANALOGY

cord and the other a piece of whipcord or heavy gilt thread, and by attaching one end of the length to the crank of the motor and by applying a tension to the other end. By adjusting the tension it is easy to show the loss in amplitude of the wave in passing such a junction, or even the total reflection of the wave, as illustrated at C, Fig. 27. This phenomenon has its electrical analogue in the loss in amplitude or reflection of the electrical waves at the junction between two conductors, say, an unloaded land line and a submarine cable or loaded line, the two having different capacities and inductances per mile, when telephonic currents are transmitted through the circuit. By means of this vibration apparatus the advantage of tapering off the loading in the case of a junction between a loaded and unloaded line can also be shown. When a wave passes from one medium to another of different refractive index, and if this index changes somewhat suddenly at the junction plane, wave reflection takes place.

If, however, the index changes gradually, the reflection losses are considerably reduced or completely annulled. Hence, if a loaded telephone cable be connected to an unloaded cable, partial reflection of the wave takes place at the junction, but if the loading is tapered off these reflection losses are considerably reduced. This can be visibly illustrated by the vibrating string apparatus in a very simple manner. If the one-half of the string be loaded with glass beads and the loading be tapered off towards the middle point, by using beads or knots of gradually decreasing mass, and one end of the unloaded end be attached to the motor crank and a tension be applied to the other end of the whole cord, it will be found that the reflection losses at the junction are considerably reduced. The partial reflection and consequent loss of amplitude in the transmitted wave can even be shown by placing a single bead or load of appropriate mass in the centre of an otherwise unloaded string, and if one end of the string be vibrated and a suitable tension be applied, it is possible to produce stationary waves of large amplitude on that part of the string between the motor and the load, but the amplitude of the vibrations produced on the far side of the load is much less, thus showing the partial loss of amplitude in the transmitted vibration, owing to the reflection losses.

In a paper read before the American Institute of Electrical Engineers in March, 1926, Professor Vladimir Karapetoff deals with the theory of absorption in solid dielectrics, and gives a mechanical analogy of an imperfect solid dielectric. In Fig. 28, A and B is a stationary plate, and C and D a similar plate connected to the former by two springs S_1 and S_2. A vessel V filled with viscous liquid is attached to the plate A and B, and a plate q supported by the spring c is immersed in the liquid. Two weights G_1 and G_2 rest on supports h_1 and h_2, and are attached to the plate C D by strings passing over stationary pulleys P_1 and P_2. The lower ends of the springs S_1 and S_2 are attached to stems K_1 and K_2, fitting into the plate A B with considerable friction. Assume the apparatus to be in a state of equilibrium with no tension on the springs and with the weights resting on their supports.

If, however, the supports be suddenly removed, the weights G_1 and G_2 will pull the plate C D upwards, and the springs S_1 S_2 and c will be extended. If the stems K_1 and K_2 fit so tightly in the holes in the lower plate A B as not to move, and owing to the viscosity of the liquid the movement of the plate q is at first negligible, the tension will, first of all, be taken up by the three springs. As the pull continues, however, the plate q moves upwards, thereby relieving the tension on the spring c, so that ultimately the whole tension is taken up by the springs S_1 and S_2, and this subsequent increase in the tension and displacement of the springs S_1 and S_2 illustrates the effect of absorption. If, however, the members K_1 and K_2 be made slightly yielding, the motion of the plate C D will not be stopped, and that gives a picture of a conduction current. If the stress be slightly changed before the final stage has been reached the additional stress put on c depends upon the position of the plate q, and thus the amount of absorption depends upon the previous history of the sample.

If the weights be suddenly removed, corresponding to a short-circuit, there will instantly be a position of equilibrium, at which the tension of the springs S_1 and S_2 will balance the compression of the spring c, and the member C D will gradually go down to a final position of equilibrium. If, however, the short-circuit be removed before the final position has been reached and the plate C D be locked, to correspond to an open circuit, a readjustment of stresses will take place corresponding to a residual charge. Thus, upon releasing C D later, another movement will take place without an application of the weights. The influence of temperature can be taken into account by changing the viscosity of the liquid in the vessel V, as, for instance, by heating it. This analogy cannot be followed in detail; but in Professor Karapetoff's opinion, it should facilitate an understanding of the general nature of phenomena taking place in an imperfect dielectric.

INSTITUTION OF PUBLIC LIGHTING ENGINEERS.

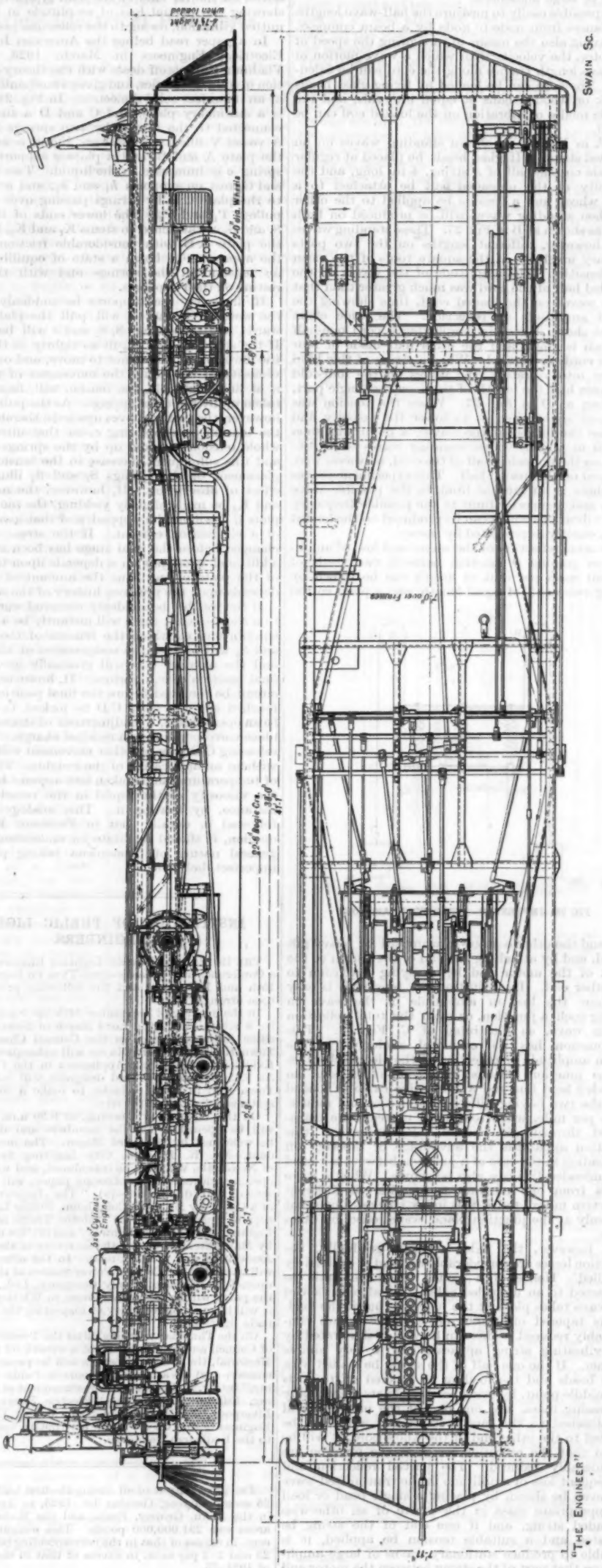
THE Institution of Public Lighting Engineers is to hold a Conference at Newcastle-upon-Tyne on September 14th, 15th and 16th next, and the following programme has been arranged :—

In the evening of September 14th, at 7 p.m., there will be a reception by the Lord Mayor of Newcastle—Councillor Anthony Oates—in the Council Chamber at the Town Hall. The Lord Mayor will subsequently open an Exhibition of Lighting Appliances in the Concert Hall. At 8.45 the members and delegates will start from the Town Hall in motor vehicles to make a survey of the systems of lighting in the city.

On the Wednesday morning, at 9.30 a.m., the Session will be opened, when the members and delegates will be welcomed by the Lord Mayor. The incoming President, Mr. R. Davison, City Lighting Superintendent of Newcastle, will then be introduced, and will deliver his opening address. The following papers will then be presented and discussed :—(*a*) "The Improved Lighting of a City," by Mr. J. F. Colquhoun, Public Lighting Engineer of Sheffield; and (*b*) "Motor Traffic in Relation to Lighting—(1) 'On the Highway,' and (2) 'On the Vehicle,'" by Major Stenson Cooke, the secretary of the Automobile Association and Motor Union. In the afternoon a visit will be paid to the Carville Power Station of the Newcastle-upon-Tyne Electric Supply Company, Ltd., after which the party will be taken by motors to Whitley Bay, where it will have an opportunity of inspecting the New Promenade lighting.

On the Thursday morning, after the President, members of Council and others have laid a wreath on the City War Memorial, the following papers will be presented and discussed :—(*a*) "Variation of Hours in Public Street Lighting," by Mr. R. Beveridge, Superintendent of Public Lighting, Edinburgh; and (*b*) "Electric Street Lighting in Liverpool," by Mr. H. Dickinson, M. Inst. C.E., Lighting Engineer of that City. In the afternoon a visit will be paid to the Redheugh Gasworks.

THE gross output of oil during the first half of the 1925–26 economic year, October 1st, 1925, to April 1st, 1926, in the Baku, Grozny, Emba and the Kuban-Black Sea areas was 231,000,000 poods. This output is 16·4 per cent. in excess of that in the corresponding period of 1924–25 and 2·2 per cent. in excess of that in the second half of 1924–25.



TASMANIAN GOVERNMENT RAILWAYS. CHASSIS OF PETROL RAIL COACH

THE DREWRY CAR COMPANY, LIMITED, LONDON, ENGINEERS

Petrol Rail Coaches for Tasmania.

Some little time ago the Tasmanian Government Railways purchased from the Drewry Car Company, Ltd., of 13, South-place, London, E.C. 2, the chassis for two petrol driven rail coaches, with a 2–4–2 arrangement of wheels, and they proved so satisfactory in service that the Government has ordered three further chassis of a larger type. These machines—of which we give a line drawing and some half-tone engravings—are to be furnished with bodies built in Tasmania, and will accommodate forty-two passengers each. Their speed is to be 30 miles per hour, and they will have to negotiate gradients of 1 in 40 and curves of 5 chains. The gauge is 3ft. 6in., and the maximum altitude of the line is 1450ft.

The most noteworthy feature of these chassis is, however, the arrangement of the engine and transmission gear as a self-contained unit quite distinct from the main framing of the body. We give a separate illustration of this power unit, which shows how compactly it has been arranged. On reference to the drawing it will be seen that the main framing is carried by the unit by means of a spherical bearing, while at the other end of the coach there is an ordinary four-wheeled bogie.

The power bogie, it will be seen, has plate frames, with inside wheels. The engine is of the six-cylinder type, with a bore of 5in. and 6in. stroke. It is capable of developing 75 brake horse-power when running at 1000 revolutions per minute. The valve chambers are all on one side of the engine, and the inlet and exhaust valves are interchangeable. They are of nickel steel with conical faces. The crank case is of aluminium, and the phosphor bronze bearings for the crank shaft are supported by high-tensile steel bolts going right through the crank case and reinforced across the caps by steel stampings. In this way the bottom half of the case is made readily removable for cleaning out without it being necessary to dismantle the crank shaft. There is an oil sump at the centre, which is provided with a gauze strainer that can be easily removed for cleaning purposes without emptying the crank case. The oil pump is of the gear type, and is arranged outside the engine at the starting handle end, so as to be thoroughly accessible. It is driven off the end of the cam shaft. There is a gun-metal centrifugal pump, for circulating the cooling water, driven off the magneto shaft at one and a half times the engine speed.

Ignition is effected by means of a Simms high-tension magneto with a vernier coupling. A Zenith carburettor is fitted, and it is supplied with petrol by an "Auto Vac." With this arrangement the suction of the engine in the induction pipe is used to maintain a small supply of petrol in a chamber fixed to the back of the radiator, and this petrol gravitates to the carburetter. In that way the risk in the case of fire is reduced to a minimum. There are two 20 gallon fuel tanks fixed in the main framing, and they are connected up with the Auto Vac. chamber by copper pipes with special flexible connections to allow for the movement of the bogie. Either of the main tanks can be shut off from the system by means of a cock, and they can be filled from inside the coach or at the side.

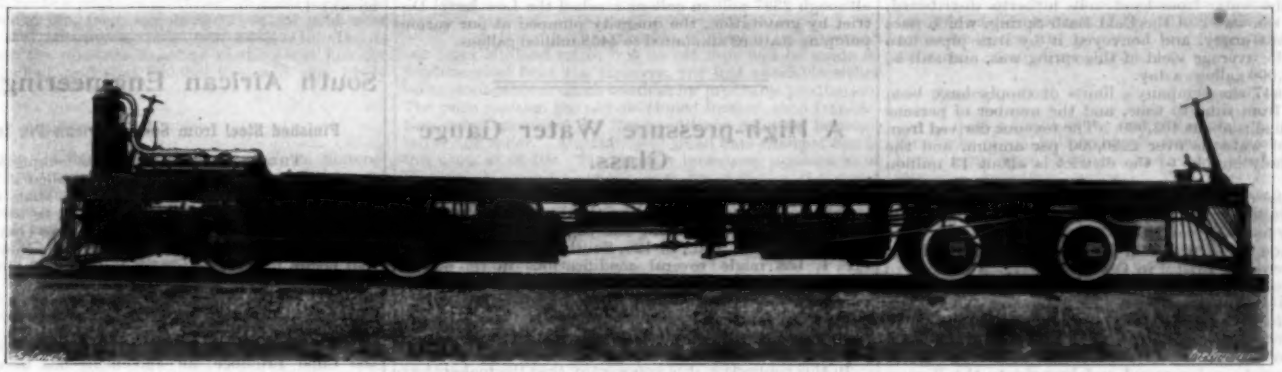
In view of the high temperature in which the coaches will have to work, a special cooling system has been provided. It comprises three separate radiators. After passing through the cylinders the water flows through the tubes of a vertical gilled tube radiator, which is attached to the unit bogie. This radiator is cooled by a fan driven from the engine crank shaft by a Whittle belt. The water then passes on to a horizontal plain solid-drawn brass tube radiator with copper tube plates and cast iron headers, rubber ring connections forming the joints. A similar radiator is fixed at the further end of the chassis. The pipes throughout are of solid drawn copper. Flexible armoured rubber hose connections are provided between the unit bogie piping and that on the main frame. A circular steel tank, with welded ends, of 30 gallons capacity is included in the circulation. This tank is fixed on the main frame. Small brass cocks are provided at the uppermost points of the radiators to free the circulation from air locks when necessary.

Besides the ordinary starting handle the engine is equipped with an electric starter gearing with a mild steel toothed ring fixed round the periphery of the fly-wheel. There are two separate dynamos, one for charging the 12-volt accumulator of the starter, and the other for the lighting accumulator. The lighting system, which is of the C.A.V. make and also works at 12 volts, includes four head lamps, four tail lamps, five interior lights, and a dashboard lamp.

The power is transmitted to the driving wheels through a gear-box, countershaft and chains. The countershaft also includes a reversing gear, so that all the speeds are available in either direction, and can be slid longitudinally on its bearers for adjusting the tension on the chains.

The clutch is of the multiple disc type, Ferodo lined, and between it and the gear-box there is a nickel steel shaft carried in ball bearings. The gear-box case is of aluminium, the gears being designed to provide three speeds of 8¼, 15½ and 30 miles per hour at normal engine revolutions. The shafts are of nickel steel and are mounted in ball-bearing housings. The gear change is effected by a sliding gear and dog. The gear wheels are machined from special forged steel, case hardened and ground where necessary. The reversing box is also of aluminium. A bevel pinion fits directly on to a castellation on one end of the gear-box primary shaft. An extension piece of the reverse box fits into an extension piece of the gear-box. These extension pieces act as an alignment for the bevel pinion shaft and allow for a movement of the box to tighten the chain drives. The shafts are of nickel steel mounted in ball-bearing housings. The gears are machine cut, case hardened and ground where necessary. The bevel wheel shaft is castellated in the centre portion, and on it there is fitted a sliding dog, which engages with the bevel wheels to obtain the direction of motion required. Chain pinion wheels are secured to the outer ends of the reverse shaft by a taper fit and key, these wheels being machine cut and case hardened, while the chain wheels on the driving axle are of cast steel, with machine cut teeth. The chains are of the Coventry "Noiseless" type. The parallel adjustment of the chains is effected by a screw attachment at each side of the reverse box. These screws are coupled

CHASSIS OF PETROL RAIL COACH FOR THE TASMANIAN GOVERNMENT RAILWAYS



together by a roller chain and gears, and a handle is used to work the gear.

The main frame for the superstructure is built up of rolled steel channels, riveted together and braced by angles and gussets, while queen trusses are arranged beneath the sole bars to stiffen them under the load. The two cross channels that connect the frame with the power unit bogie are reinforced horizontally by diagonals and longitudinals attached to the head stocks. The trailing bogie support consists of two plates reinforced by angles, &c. These plates are secured to the headstock by longitudinal channels, angles, and gussets to the sole bars. The bogie centres are of cast iron.

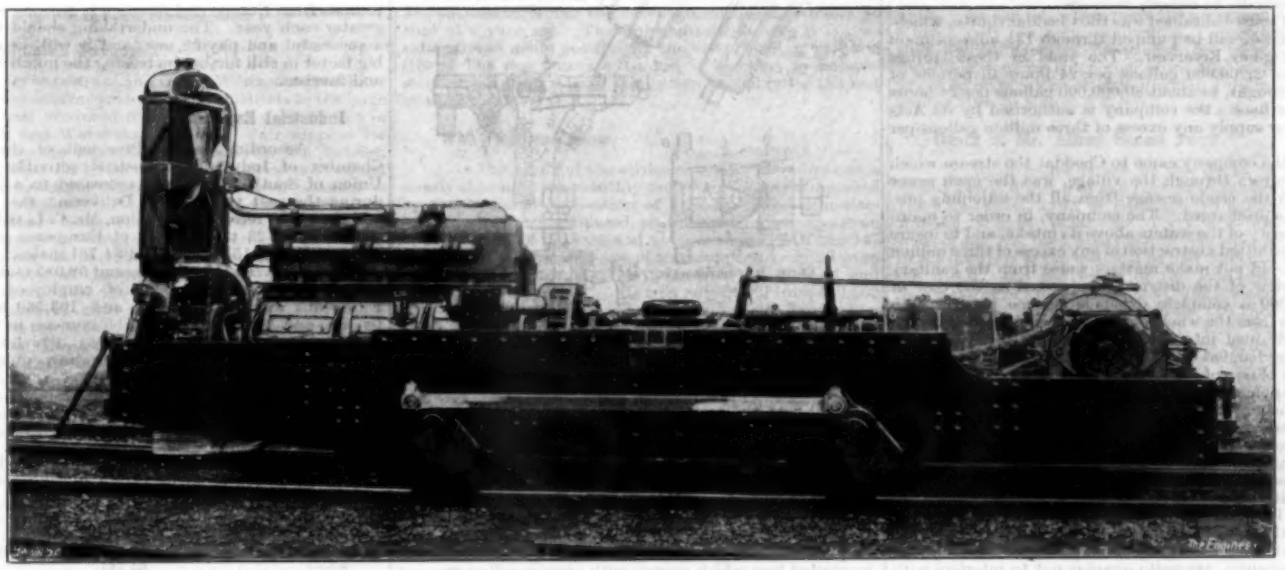
The side members of the power bogie are of steel plate, with bogie centre girders of rolled steel channels. These channels, with the end plates, are secured to the side members by angles and gussets riveted thereto, so that the whole assembly provides a very rigid structure. There are also longitudinal central channels for carrying the engine, gear and reverse boxes. The side movement of the power unit bogie is controlled by two vertical spring shackles at the front end, which are secured between the headstock of the main frame and the bogie. The bogie can readily be removed from the chassis for overhauling by taking out the bogie centre pin and disconnecting the control rods and the water and petrol pipes.

The wheels are the Newlay type of rolled steel 24in. in diameter, and are pressed on to axles with journals 3¾in. by 5½in. The axle-boxes are of cast steel, with phosphor bronze bearings lined with white metal, arranged for syphon lubrication and with spring oil pads. The wheels and axles of the trailing bogie are the same, except that the journals are 3¾in. in diameter by 6½in. long.

The brakeing system comprises two drums on the countershaft, which are worked by a foot pedal and brake shoes on all the running wheels operated by a screw handle at either end of the car.

All the controls are, of course, duplicated at either end of the coach, but the driver has to carry with him the pedals and levers so that the gear at the dead end of the car cannot be interfered with by unauthorised people. There is also an interlock between the clutch and the gear-changing lever to prevent the gear being changed with the clutch in engagement. The controls from each end of the chassis are carried to universal jointed levers mounted on cross members in the centre of the chassis, in order to avoid any undue length in the rods, and a special arrangement has been fitted to enable the driver readily to discover the position of the gears he is using. The control rods are, of course, articulated to accommodate movements of the power bogie.

Besides the chassis which we now illustrate, the Drewry Car Company is also supplying the Tasmanian Government with two vehicles with a 2–4–2 wheel arrangement, and fitted with 60 horse-power four-cylinder engines, having a bore of 5½in. and a stroke of 6in. These two coaches are, in fact, slightly larger examples of the two original vehicles mentioned at the beginning of this article.



POWER BOGIE OF PETROL RAIL COACH

Bristol and Its Water Supply.

In the Presidential address delivered by Mr. H. E. Chattock, chairman of the Bristol Waterworks Company, before the recent summer meeting at Bristol of the British Waterworks Association, some interesting particulars were given of the history and present position of the city's water undertaking. We reprint below some abstracts from the address.

Bristol, like many other towns, was originally supplied with water from a number of conduits, some of which are several hundred years old. John Leland, writing in 1534, mentions that there were seven such supplies in his day; these were distributed over different areas, each parish supplying its own religious houses first. Documentary evidence, however, proves that any surplus water not required for themselves was under certain conditions allowed to be taken by the adjoining parishes; thus even in those early days there appears to have existed a local "Regional Water Committee."

In addition to the supplies already mentioned, there were Jacob's Wells Spring, Temple pipe, St. Peter's, Wine-street, Pithay, and other pumps and wells.

One of the oldest of the conduits, which is still in existence, has its outlet close to St. Mary's Church, Redcliff. The water comes from Knowle, two miles away, which over seven centuries ago was granted by Lord Robert of Berkeley to the Churchwardens of Redcliff for the use of the inhabitants.

On February 5th, 1695, the first Bristol Waterworks Company was formed, and received the Royal Assent in 1696. The water was brought in pipes of elm from the Avon at Hanham Weir, where the ruins of the engine mill still exist, to a reservoir at Lawrence Hill. Barrett, the Bristol historian, says that this reservoir was filled by a water wheel engine at Hanham Mills; but Latimer's Bristol Annals state that the supply was taken from Hanham Mills to Conham or Crew's Hole, and from thence driven to higher levels at the reservoir at Lawrence Hill by an ingenious machine, possibly a primitive steam engine. There is some doubt about a steam engine in connection with this scheme. If an atmospheric engine, it could not have been in use before 1712, the year in which Thomas Newcomen started his first engine near Wolverhampton. Before his day there was only the engine invented by Captain Thomas Savery, whose patent was applied for in 1698. The elm pipes have been found in opening up the roads in Old Market, West-street, Temple-street, and other streets. There are specimens at the Bristol Sanitary Authority depôts, and at the Bristol Waterworks Office. As the scheme did not answer, it was set aside in 1783; as Barrett says, "the great supply of water for the use of the citizens from pumps and public conduits rendering it the less necessary."

In 1811 another scheme was promoted for providing Bristol with water, by means of a canal between Bristol and Bath, which was to terminate at the end of Old Market-street. The scheme also provided for a reservoir and pumping station at Lawrence Hill, and two reservoirs, one at the top of Stokes Croft and the other at Cotham, with pipe lines between them, and a pipe line from the proposed reservoir at Cotham to the site of the Zion Spring at Clifton. Nothing came of this project, but in the same year the Zion Spring was tapped, and several hundred houses in Clifton supplied therefrom.

In November, 1841, notice of an application for parliamentary powers was given by the Society of Merchant Venturers to supply Clifton and neighbourhood from various springs, principally the Lower Hotwells Spring near Black Rock. The Bill was dropped. At this time there were about 400 houses connected with and supplied from Zion Spring; another hundred from the wells known as Richmond and Buckingham Springs, and a few from Jacob's Wells. The city was still dependent upon the surface wells and old springs which had been in use for several centuries. As the growth of the city rendered more plentiful supplies urgently necessary, a town's meeting was called in 1840, at which it was proposed to form a Bristol and Clifton Waterworks Company. This fell through for want of support.

In 1845 the Society of Merchant Venturers set about the construction of works for tapping the spring under the sea walls and the erection of an engine-house, while excavations for a reservoir were made on Observatory Hill. It became evident that the scheme was too limited, and a severe struggle ensued between the Merchant Venturers and the promoters of the present company, before a Parliamentary Committee, which resulted in the incorporation of the Bristol Waterworks Company in 1846.

It was not too soon, for the condition of the City of Bristol and the surrounding neighbourhood as regards water supply was at that time deplorable. An official report presented to Parliament in 1845, by Commissioners appointed to report on the health of certain large towns, stated that "the City of Bristol, containing 130,000 inhabitants, had a most inadequate water supply, probably more so than any town of equal size in England." It was estimated that not more than 5000 persons, constituting the most wealthy families, were supplied by pipes laid into their houses, the remainder of the population being dependent on wells, the water from which was frequently unfit for use because it was tainted by the overflow and soakings from cesspools. The condition of the poor inhabitants was described as "extremely filthy" owing to the difficulty of obtaining water, and it was reported by the same Commissioners that in some parts of Bristol, to which water was carried by a water carrier, the charge was 30s. a year to the poorest family.

The 5000 persons alluded to as supplied by pipes, took water from one of the three small works, of which the largest was owned by the Society of Merchant Venturers and the other two were the property of private individuals; all three obtained their water from local wells which were

subject to contamination. In 1847 the total income derived by the three undertakings from the sale of water was only £1700 a year. The Bristol Waterworks Company acquired these three works in 1847, closed them, and, in place of the water from local wells hitherto distributed, delivered the water of the Cold Bath Spring, which rises at Barrow Gurney, and conveyed it by iron pipes into Bristol; the average yield of this spring was, and still is, about 540,000 gallons a day.

Since 1847 the company's limits of supply have been extended from time to time, and the number of persons now supplied is about 403,000. The revenue derived from the sale of water is over £280,000 per annum, and the average daily supply to the district is about 13 million gallons.

From these figures you will appreciate the growth of the undertaking, and the benefit which the inhabitants of our city have derived from it.

I have mentioned the Cold Bath Spring; this water was first delivered in Bristol in October, 1847. Additions to this source of supply followed in 1850, when water from springs in the carboniferous limestone and the conglomerates of the Mendip Hills was brought into the system. This source consisted of springs which rise at Chewton Mendip and which were collected with other springs at different points underground and brought to the Barrow Store Reservoirs by 10 miles of aqueduct pipe line and tunnel.

The first and smallest of the three Store Reservoirs at Barrow Gurney was completed in 1852, the second one adjoining it was finished in 1868, and the third and largest has been in use since 1891. The total capacity of these three reservoirs is about 850 million gallons. In 1867 a further source of supply was obtained by pumping from deep wells in the new red sandstone and marls of the Triassic formation at Chelvey, about five miles from Barrow Gurney. This water can be pumped either to the Store Reservoir at Barrow Gurney or direct to Bristol. The next addition to the sources was carried out in 1885, when the water of the Sherborne Spring, which rises in the Mendip Hills, was brought into Bristol by 13 miles of pipes. This spring, which varies in volume from 1 to 1½ million gallons per day according to season, is of exceptional purity and gravitates direct from its source to the consumers in Bristol.

The next source obtained was the impounding reservoir in the Yeo Valley, about 12 miles South-West of Bristol, known as the Blagdon Reservoir, which has a capacity of nearly 1700 million gallons, together with the Rickford and Lanfgord Springs. Water is pumped from Blagdon Reservoir to Barrow Gurney. The top water line area of this reservoir is 480 acres, and the drainage area, which is 5000 acres in extent, is not only highly cultivated, but includes four villages and many isolated farms and cottages. The company has, therefore, been put to very heavy expense in constructing sewerage works to treat the drainage from the villages and to carry the effluents to a point below the watershed. The isolated farms and cottages are dealt with individually as regards drainage.

The last source obtained was the Cheddar source, which, when required, will be pumped through 13½ miles of main to the Blagdon Reservoir. The yield of these springs varies from 2,200,000 gallons per 24 hours in periods of extreme drought, to about 80,000,000 gallons per 24 hours in times of flood; the company is authorised by its Acts to pump for supply any excess of three million gallons per 24 hours.

Before the company came to Cheddar the stream which flows therefrom through the village, was the open sewer into which the crude sewage from all the adjoining properties was discharged. The company, in order to maintain the purity of the waters above its intake, and to insure that the permitted abstraction of any excess of three million gallons should not make matters worse from the sanitary point of view of the district, constructed at the cost of over £52,000 a complete drainage scheme to deal with the sewage from the whole of that part of the village which formerly drained into the river. These works on completion were handed over to the Local District Council.

Cheddar is one of the beauty spots of the country, and when we applied for our Bill to take water from that district we encountered some opposition, as it was feared we might interfere with the amenities of the place. Before the completion of our work, however, several unsightly old buildings were cleared away; the ponds have not only been cleaned out but provided with protective areas, planted with shrubs and ferns, and I am glad to say the company has received many congratulations from the public on the improvements effected. Waterworks undertakings, whether belonging to corporations or to public utility companies, are quite anxious not to interfere with the amenities of any district from which they draw their supply of water.

I have now mentioned all the sources from which the company draws its present supply. In addition to the works named, there are large compensation reservoirs for regulating the supply of water to the mills on the river Chew; the water from these reservoirs, however, is not supplied to any part of the company's district. The quantity of compensation water which has to be delivered daily from these reservoirs and the Blagdon Reservoir is 5,130,000 gallons, equal to about 13 gallons per head of the population supplied by the company.

Unfortunately, owing to war regulations, our Cheddar works could not be commenced in time to carry us through the record drought which occurred in the year 1921, when we had to break a proud record of thirty-eight years' constant service by curtailing the supply daily for a period of sixteen weeks.

The stratigraphical conditions in regard to diversity of levels and contours and general configuration of the Bristol and district areas, is such that the provision of water supply has involved the heavy capital expenditure of nearly £3,000,000; the physical difficulties, in obtaining pure water in sufficiently large volume, making the cost of the water greater than in many large towns.

The yield of the gravitation sources is only sufficient to supply about one half of the present consumption. The remainder has to be pumped; and as any increase of the present consumption must be met by the new Cheddar sources, it follows that the water required to meet the increased consumption must be twice pumped before it reaches the Low Level District, three times pumped before it reaches the High Level District, and four times pumped before it reaches certain high peaks of our area.

The respective lifts are:—Cheddar, 300ft.; Blagdon, 250ft.; Clifton, 200ft.; Lodge Hill, 47ft.

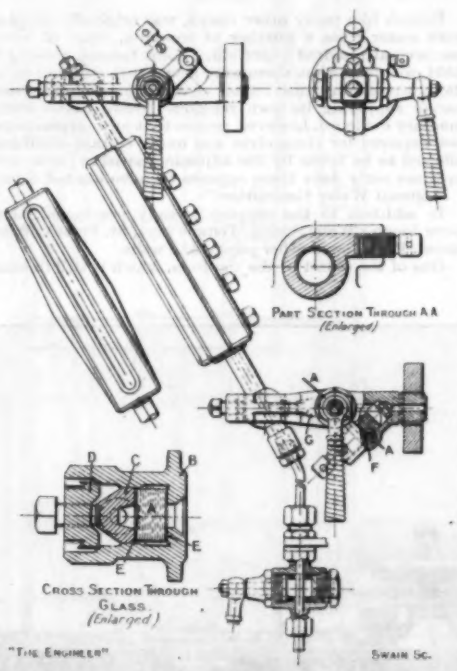
In the year 1925 the total water supplied by the company was 4602 million gallons, excluding compensation, and although 2397 million gallons reached the Low Level District by gravitation, the quantity pumped at our various pumping stations amounted to 4458 million gallons.

A High-pressure Water Gauge Glass.

With the object of providing a water gauge glass capable of safely withstanding the high boiler pressures which are rapidly becoming the vogue in power stations, Richard Klinger, Ltd., of 120, Southwark-street, London, S.E. 1, has made several modifications in its original form of prismatic glass, which shows the water in black, while the steam space above is bright. This effect is, of course, produced by refraction from the ribbed inside face of the glass, as shown in the cross-section of the drawing reproduced below.

In this connection it is noteworthy that the makers have recently carried out some extensive investigations in glass making, and have evolved a formula which produces a glass which is said to be more resistant to corrosion by boiler water than any previously known.

From a mechanical point of view, the chief difference between the new and old forms of Klinger gauge is in the means adopted for making a tight joint between the flat gauge glass and its framing. The original arrangement of a set of screws around the periphery of the frame must be familiar to most of our readers, and serves its purpose for moderate pressures; but higher pressures naturally involve a greater force to keep the glass tight on its seating, and with the original scheme the pressure was liable to be unevenly distributed, with the result that the glass would be cracked.



DETAILS OF HIGH-PRESSURE WATER GAUGE GLASS

The new arrangement overcomes this trouble in the following manner. The glass A—see the cross section—is clamped in the frame B by means of the backing piece C and the bar D. The backing piece, it will be seen, is hollow to provide a water space, and Klinger jointing gaskets are provided at E E to make the joints tight. The bar has dovetailed lugs which engage with corresponding recesses in the main frame. The lugs and the recesses are cut away at regular intervals, so that the bar can be slid longitudinally "one notch," as it were, and can then be lifted out of the framing to release the glass. A series of set screws is tapped into the bar for clamping the backing piece down on to the glass and making everything tight.

Two other refinements in the gauge are the provision of screw-down plugs which can be used for isolating the gauge fittings, and a device to check the discharge of water in the event of the glass breaking. The plugs, one of which is shown at F, in partial section, can be screwed down on to seatings in the passages on the boiler side of the gauge cocks, which can then be removed for overhaul, while the boiler is under steam. The screws of the plug are made tight by soft packing inserted through a tangential hole, as indicated in the sectional sketch.

The check to prevent the escape of water in the event of accident takes the form of a ball G, which is forced up against the outside seating by the rush of water if the glass is broken. A ball is not provided in the top fitting for the reason that there might be a liability for it to be held in the closed position after the gauge was set to work again, while the discharge of dry steam from the top of the glass is less disconcerting to the attendant in closing the cocks than is that of the hot water from the bottom.

It will be noticed that the blow-through cock is separated from the bottom fitting, as the gauge is primarliy intended for fitting on tall water-tube boilers, where it is out of reach, and is connected up at a lower and more convenient level by piping. All three cocks are of the parallel plug type, packed by means of Klinger rings.

These gauges, with the exception of the jointing material, are made in England, and while the original pattern is still serviceable for pressures up to 300 lb. per square inch, the new type is intended for working pressures as high as 1000 lb. per square inch. Generally speaking, the water level can be easily seen in them at a considerable distance, but when required a special lighting device can be added.

South African Engineering Notes.

Finished Steel from South African Pig Iron.

The first steel rails into the composition of which South African pig iron enters were rolled at Vereeniging on July 7th. It is interesting to note that pig iron from Newcastle had already been delivered to at least half-a-dozen of the local engineering works, so that well within the first three weeks of its starting up the Newcastle works had begun to have an influence on the Union's industrial undertakings.

Aerial Cableway up Table Mountain.

Subject to the approval of the Administrator of the Cape Province, an agreement has been arrived at between the City Council of Cape Town and a company styled the Table Mountain Aerial Cableway Company, Ltd., under which the company is given the sole rights to construct, run, and maintain at its own cost an aerial passenger cableway service to the top of Table Mountain. The motive power of the undertaking is to be electricity, the supply of which is to be taken from the City Council's power station, but the company is entitled to establish and maintain an auxiliary oil engine for use in emergencies. The company is to commence operations for the carrying out of the undertaking, including the construction of an approach road to the point from which the cableway is to start, which is some distance upon the lower slope of the mountain, not later than October 1st, 1926, and is to complete it within three years after the date of the agreement. Provision is made for the expropriation of the undertaking by the City Council after it has been running for not less than fifteen years from the date on which the construction of the undertaking is completed.

Table Mountain rises directly at the rear of the City of Cape Town, as seen from the sea, to the height of 3582ft., cutting the skyline with a jagged horizontal front, two miles in length. The mountain is exceedingly difficult to climb, and in parts is a sheer precipice. Plans for a mountain railway were drawn up a number of years ago, but the idea was abandoned owing to doubt as to its proving payable. Since then the population of the City of Cape Town and suburbs has very largely increased, the total amounting to about 160,000. In addition, over 50,000 visitors from various parts of the Union come to stay in the seaside suburbs during the summer months, while the number of tourists from Europe and America is growing considerably greater each year. The undertaking should therefore be a successful and paying one, and it will, no doubt, be a big factor in still further increasing the numbers of visitors and tourists.

Industrial Expansion.

According to the President of the Federated Chamber of Industries, industrial activities within the Union of South Africa have increased to a large extent during the past year or so. Delivering the presidential address at the recent Convention, Mr. C. L. Giband stated that in 1922–23 the number of Europeans employed in industry was 6515 females and 54,781 males. In 1923–24 the numbers were 7104 females and 59,085 males. During the same period the number of employees other than Europeans was 7201 females and 103,550 males; 7136 females and 109,552 males. The increase in the number of Europeans employed is 8 per cent., which is four times as great as the growth of the European population.

Mineral Output for Half Year.

For the first half year of 1926 the total value of the mineral production of the Union is declared at £27,838,235, as compared with £26,919,733 for the corresponding period of 1925. The following are the details with the corresponding figures for 1925:—

	1926. £	1925. £
Gold	20,751,513	20,318,802
Silver	65,744	86,882
Osmiridium	45,114	68,195
Diamonds	4,483,497	3,950,095
Coal	1,915,405	1,948,047
Copper	264,174	276,636
Tin	160,179	138,172
Other minerals	152,609	132,904
	£27,838,235	£26,919,733

Gold Mining Records.

The year 1926 promises to see more records achieved by the Rand Gold Mines than ever before in one year. During the first six months of the year the total monthly gold production has on three occasions put up new records. For the month of March the gold produced was 834,340 oz., being 4000 oz. above the previous best. During May 849,214 oz. were obtained, and for June the total was 852,145 oz., while it is very likely that the figures for the month of July, when available, will show a total several thousands of ounces higher still. Unless something entirely unforeseen occurs the total gold production for the year will not only be far ahead of the previous best but will show the enormous quantity of 10,000,000 oz. and a value of £42,500,000—in round figures. Another record already created in 1926 is for a single mine to earn a monthly profit of over £200,000. That has been achieved by the Government Gold Mining Areas—so called because the Government receives a share of the profits based upon a formula which gives a larger percentage to Government according as the profit earned becomes greater. Up to lately the figure has been about 55 per cent. The Government Areas has for some time been enlarging its plant, and the new portion came into operation in May, though it was not in full swing until June. The following monthly

figures show how the addition has affected the output :—In April the mine crushed 160,000 tons of ore from which 73,265 oz. of gold were obtained, the profit being £170,031 ; in May the mine crushed 188,000 tons, recovered 82,683 oz. of gold, and made a profit of £200,596 ; in June it crushed 200,000 tons of ore, from which 89,321 oz. of gold were recovered, and the profit made was £220,341. It is believed that the ultimate capacity of the plant has not yet been reached, and that 220,000 tons will very likely be achieved.

Railway Accidents.

Since the derailment of the Cape Town–Simonstown suburban train on June 9th last, there has been an extraordinary number of such accidents, fortunately without any injuries to those on the trains. Very shortly afterwards a goods train had some of its trucks derailed at the same spot at Salt River, and at least three similar accidents have occurred up the main line. In one case, where eight trucks left the rails, the Johannesburg–Cape Town mail train might have been involved, and, as it was, was held up for hours. The frequency of these derailments is causing some people to question whether the much heavier engines now used on the narrow gauge—3ft. 6in.—lines, and the higher speeds are the causes of the trouble. The latest engines weigh 178 tons, whereas but a very few years ago the weight was about 100 tons, and even under 100 tons, and much higher speeds are customary. Within a year the time from Cape Town to Johannesburg, 956 miles, has been cut down from 39 hours to under 30 hours, yet the weight of rail is the same. The latest accident was not, however, a derailment and might easily have been very serious but for the presence of mind of the two engine drivers. About two o'clock in the morning of July 23rd the mail train from Rhodesia was turned into a loop, just beyond Worcester, in order to allow a goods train, going north, to pass. By some means or other the goods train entered the loop and the two engines met head on. The respective engine drivers instinctively were on the alert. One reversed his engine and plied his brakes, whilst the other released his brakes in order that the train should "give" before the collision. As it was passengers were thrown out of their bunks and glass and crockery was smashed, while some of the goods train's trucks were derailed. Three passengers, two women and one man reported themselves as having suffered shock and bruises. The main line was blocked for a time, and the Rand mail from Cape Town was held up about three hours.

Provincial Letters.

THE MIDLANDS AND STAFFORDSHIRE.

(From our own Correspondent.)

West Midlands Favoured.

STAFFORDSHIRE and East Worcestershire have been fortunate as compared with some districts in the large tonnage of coal produced during the last week or two in the Cannock and Warwickshire fields. Fair supplies for industrial purposes have been available in the district, sufficient at least for those concerns which do not require abnormal quantities. These supplies have enabled a number of forges and mills to restart in the Dudley and Netherton area. Noah Hingley and Sons, Limited, for instance, are now making a very fair output, and some other works should be able to follow shortly. There is, of course, no hope of the steel works at Bilston restarting for a long time, until the coal deadlock is settled and regular supplies of good fuel are available. In many branches of manufacture considerable difficulty is being experienced in obtaining supplies of raw materials, and some of the constructional engineers are being held up owing to the shortage of British steel. All sections of the Midland engineering trades are well off for orders, particularly the electrical firms. Rolling stock makers are regularly employed.

Market Position.

There was little fresh business at the weekly meeting of the Midland Iron trade at Birmingham to-day —Thursday. Merchants and consumers showed more concern as to supplies when fuel becomes available for a full resumption, but negotiations were tentative. There was a marked falling off in business, both in home and foreign steel, but this decrease is not due to any lack of demand, consumers merely awaiting the arrival of the time when quotations can be safely made and accepted. Some attention continues to be paid to foreign materials. Continental prices are stiffer. Market stringency encourages producers to demand more, and a further factor in the appreciation is the rise in freights.

Finished Iron.

There is very little change in the manufactured iron industry of Staffordshire. The works lately reopened near Dudley are in operation, and are turning out fair quantities of wrought iron. The makers of best iron are disposed to wait until the usual supplies are available. The works have very good order books, and are assured of full operation for some time. Some sales of Staffordshire bars have been arranged, subject to price adjustments, when the position has become more clearly defined. Until they can get a better selection of coal, forgemen are not able to initiate any new enterprise of moment. Some Belgian No. 3 iron for the nut and bolt trades continues to arrive in the district. The price has, however, advanced by 2s. 6d. per ton, making the new quotation £6 2s. 6d. delivered. Deliveries, in limited quantities, are also being made of Lancashire Crown bars. For months before the strike users of wrought iron, hoping for lower prices, bought as little as possible, with the result that when the strike came about they had no material in stock. For months, therefore, they have been glad to make use of material available from manufacturers' and merchants' stocks aggregating some thousands of tons. Holders of this material have to some extent profited by turning their stocks into money, but greatly enhanced prices have not been obtained. Fair quantities of tube strip are being produced in the district, and are proving useful to the local steel works.

Steel.

A fairly large aggregate of steel is being turned out from Midland mills, but no attempt will be made to produce steel from the furnaces, the fuel available either being unsuitable or much too dear for profitable production. The price position has not developed further, each transaction being governed by the conditions existing between buyer and seller. A quantity of small bars changed hands this week at £8 10s. The steadily increasing production of Warwickshire and Cannock coal has relieved the stress at local mills, this fuel largely taking the place of the pit-mound residuals on which the mill men have had hitherto to rely. Foreign steel quotations have advanced by several shillings per ton. Continental works have plenty of orders, and as delivery in many cases cannot be given under three months, while prices are now approximating to those of British furnaces for semi-finished steel, there is little inducement to buy. However, the large use of foreign material is indicated by the monthly trade returns, the imports of steel billets, slabs, &c., reaching 76,549 tons, while very large figures were recorded for such products as bars, angles, joists, &c., showing substantial increases over last July.

Raw Iron.

Supplies of native pig iron have become precarious, but so many plants have stopped, or are operating only intermittently, that the demand has shrunk to small dimensions, and the market betrays hardly any sign of tension. Very little pig iron is now coming in from Scotland. Foundries are getting occasional deliveries from Cleveland, the price for No. 3, delivered here, being about £5 7s. per ton. This brand is the most suitable to Midland foundries, but the high price is regarded as prohibitive by many consumers, and a very useful alternative is the French pig iron, of which good quantities have been distributed at 10s. to 15s. less per ton than the Middlesbrough brand. It is said to resemble Northampton iron, and is proving suitable for local requirements. Continental values are, however, advancing, while deliveries are belated, so that any big development of this business is not anticipated. Coke is increasingly difficult to get, frequently costing £3 5s. and upwards.

Galvanised Sheets.

The galvanised sheet trade continues busy, some works having made full production. Values remain steady, 24-gauge corrugateds commanding £17 to £17 10s. per ton according to date of delivery. It is noted by industrialists hereabouts that galvanised sheets reached an export figure of 53,602 tons last month, as compared with 39,768 tons in June, the total approximating closely to that of a year ago. This substantial business, it is considered, was made possible by the use of foreign coal and steel. The new business booked is reported to be substantial, assuring a large production probably for the rest of the year.

What Returns Show.

The effect of the strike on the basic industries is clearly shown by the monthly production returns furnished by the National Federation of Iron and Steel Manufacturers. As was anticipated, an almost complete cessation of production of pig iron and steel is shown. Of the 147 furnaces in blast on the eve of the stoppage, only 23 were in operation at the end of May, 11 at the end of June, and eight at the end of July. Pig iron output fell from 539,100 tons in April to 17,900 tons in July last year. Production of steel ingots and castings in July amounted to 32,100 tons, compared with 34,500 tons in June, 45,700 tons in May, 661,000 tons in April, and 590,400 tons in July last year. The Board of Trade returns indicate to some extent how this deficiency has been made up from foreign sources. Steel billets were imported to the amount of 76,549 tons, against 43,010 tons in the same month last year. Steel girders, &c., bought abroad reached the large figure of 11,182 tons, against 9000 tons a year ago, and plates and sheets 21,375 tons, compared with 16,676 tons. We bought from the foreigner 10,106 tons of scrap, against 4441 tons in July last year. Imports of forge and foundry pig were more than trebled, amounting to 15,800 tons, and over 1000 tons came from America. We bought more basic iron from Belgium, but less from other sources. Altogether, our outlay on foreign supplies of iron and steel amounted last month to £2,209,576, against £1,938,951 in June.

Birmingham's Exports to America.

Though the record of exports from the Birmingham district to America during the second quarter of the year compares unfavourably with that for the corresponding period of last year—a turnover of 1,979,696 dollars, in the second quarter of 1925 declined to 1,785,994 dollars this year, a fall of roughly 10 per cent.—iron and steel manufactues showed an encouraging increase from 74,370 dollars to 127,298 dollars, approximately 70 per cent. Progress was also recorded in the export of steel sashes, which rose from 58,857 dollars to 66,275 dollars, brass manufactures from 67,641 dollars to 68,778 dollars, and chemicals from 25,205 dollars to 32,630 dollars.

Industrialists Surprised.

Iron and steelmasters in the Midlands were agreeably surprised at the returns of exports for last month. It is considered that the industries made a surprisingly good show considering their dependence on coal, and the preponderant extent to which they use solid fuel. The June export of iron and steel was exceeded by more than half a million, the total reaching £4,579,252. Another pleasing feature was the increased shipments of machinery. It is evident that if the deadlock in the coalfields is maiming some branches of heavy engineering, compensation is being found in stimulated activity in other departments, so far as the foreign markets are concerned. Machinery was exported last month to the value of £4,181,293, an advance on the July shipments in the two previous years, and three-quarters of a million better than the June total. In spite of the fact that most of our blast-furnaces were out of action, we contrived to increase our exports of pig iron last month by nearly 50 per cent. The total of 32,164 tons is little below that of the preceding July. Forge and foundry makes accounted for 25,460 tons—a significant commentary on the plight of our forges and foundries at home.

American Coal.

As a result of the continuance of the coal dispute the stocks of coal held by the Birmingham gas undertaking have nearly come to an end, and steps have been taken to purchase American gas coal. The extra cost involved, not only in these purchases, but in the picking up of coal from stock over no long a period, is substantial, and is likely to continue for some time, so that the Gas Committee has now announced an increase in the price of gas of 6d. per 1000 cubic feet, which will apply to all gas consumed after the September readings of the meters. The Committee intimates that the purchase of one week's requirements of American coal involves the department in an increased charge of approximately £15,000 to £18,000 per week.

Mining Situation.

The very marked "back to work" movement on the part of the miners' rank and file continues, being particularly pronounced in the Midlands, and Mr. Cook's whirlwind campaign has not influenced the situation here. Disregarding the advice of their leaders, the miners of Warwickshire are flocking back to work in ever increasing numbers. The latest figures for the whole of the Warwickshire coalfield show an increase of 431 over Saturday last. Over 7000 men are now at work in the Warwickshire coalfields, every pit showing a substantial increase. The number of miners of all grades at work in the Cannock Chase area has passed the 6000 mark, and the railway company has resumed the running of special daily trains to convey miners from the outside districts to and from the pits at Cannock, Hednesford, and Rugeley. Miners continue to drift back to work in increasing numbers in the West Midland area. Collieries at Cradley are still working with the full complement of 450 men, and at Halesowen 138 have returned out of 300 engaged in normal times, whilst at Rowley 206, nearly half the total usually employed, have signed on. There has been a further increase in the number of miners returning at Baggeridge Colliery, Sedgley—one of the largest in the Midlands—the total exceeding 300. There are also substantial additions at most of the other nineteen pits in the Sedgley and Dudley district. At the Walsall Wood and Aldridge Collieries more men have resumed work. There has been a steady drifting back in the North Staffordshire coalfield for the past week, particularly in the area of Stoke-on-Trent. The total at work exceeds 5000, compared with 4000 last week. At one pit, where more than 550 men are at work, a night shift has been commenced. The North Staffordshire Colliery Owners' Association has posted notices at the pits extending the period of its offer of April rates of wages on an eight-hours day, made in July last, from September 30th to March 31st next.

Death of Mr. Alfred Ernest Terry.

Much regret is felt at the death of Mr. Alfred Ernest Terry, director of and partner in the firm of Herbert Terry and Sons, Ltd., of Redditch, which took place on Monday, August 16th. Mr. Terry who was fifty-three years of age, had been with the firm ever since he left school. In the interests of the business he had travelled throughout the U.S.A., and the whole of the European Continent. As a member of the Management Committees of the British Cycle and Motor Cycle Manufacturers, Ltd., and the Society of Motor Manufacturers, Ltd., Mr. Terry had helped to develop the exhibitions promoted by those bodies. If success is measured by personal regard, then "Mr. Alfred," as he was always called, was eminently successful, for he carried the regard of staff and works, and in his death it is felt that they all have not only lost an employer, but a friend. Yet beneath it all was an ability to maintain discipline. He could reprove and leave no rancour ; he could think a way through difficulties and help the daunted, and send them back to work with new hope.

LANCASHIRE.

(From our own Correspondents.)

MANCHESTER.

General Outlook.

ALTHOUGH there is keen disappointment that last week's meeting between coalowners and miners' representatives failed to produce anything which might have led to a national settlement of the dispute, the markets here are hopeful that the "drift-back" in various parts of the country may have the same effect in the end. Employers in the engineering trades of Lancashire are naturally not displeased that the York conference of the Federation of Engineering and Shipbuilding Trades Unions has decided to defer its national and local applications for an advance of £1 a week. This matter has been a disturbing factor for a long time, and more particularly during the last few months preceding the general strike. It is not many weeks since, that a local trades union official stated that the application for the wage increase was to be fought out to the end. The latest development, however, seems to point to a realisation by the trade union leaders in the engineering industries that the events of the last four months have not improved the economic position. In this area keen interest is being taken in the appointment by the Manchester Chamber of Commerce of a sub-committee to consider a proposal by which it is sought for a period of seven years to avoid strikes and lock-outs, and several engineering firms have expressed their approval of the scheme. A matter of interest that ought to be recorded is the resolution of the Metal Trades Group of the Manchester and Salford Trades and Labour Council urging affiliated unions to instruct their members

not to undertake the conversion of locomotives or boilers from coal to oil fuel during the period of the miners' dispute. Representatives of the Amalgamated Engineering Union have declared definitely that their members would not carry out any such instructions.

Non-ferrous Metals.

Tin values have swung back again, and although the whole of the previous loss has not been wiped out, a substantial recovery has been made and the market at the time of writing remains steady. Apart from speculative transactions, which have been much in evidence during the past week, there has been a fair volume of buying by domestic consumers and also by United States interests. Available stocks in this country show a temporary increase, but it is not very heavy, and with English and Dutch varieties in short supply it is anticipated that the coming month-end statistics will favour the "bulls." Values on the copper market have fluctuated rather sharply, the relatively high prices touched at one time not being maintained. Buying interest in this metal has been good, British cable manufacturers entering the market for fair quantities, while the consumption in the United States has been well up to its usual level. The result is that prices are higher on balance, the market finishing up on a steady undertone. In the case of lead the demand has been rather quiet, but it has been good enough to maintain prices at a steady level. Spelter also has not moved appreciably either up or down, and although sales are only moderate the fact that stocks, according to the latest available estimates, show a fairly substantial reduction, has been sufficient to keep values up.

Iron.

The iron market locally has been devoid of any particularly interesting feature since last week. Up to the present few other makers have seen fit to follow the lead set by a Derbyshire iron producer in connection with prices for delivery when coal production is resumed. Most of them continue to follow a waiting policy, but it is not unlikely that this will be abandoned in many instances before very long, for the return to work at the mines in some of the principal pig iron producing districts is already on an important scale. In some cases pits belonging to iron and steel concerns have started winding again, and although, of course, as yet, at nothing approaching normal capacity, it is felt here that outputs will soon be sufficient to warrant some, at least, of the blast-furnaces being put into commission. Small orders are being placed with those ironmakers who are prepared to book forward, but buyers generally, as well as most of the producers, are inclined to proceed with caution. In the meantime Derbyshire No. 3 foundry iron for post-stoppage delivery is being offered in some quarters at 80s. per ton at the furnaces, or 88s. 6d. to 90s. delivered in the Manchester district. Apart from Scottish No. 3 and hematite, which are on offer at 106s. to 107s. 6d. and 98s. 6d. per ton, respectively, for delivery Manchester or equal, there is practically nothing available at the moment for prompt. Lancashire bar iron manufacturers continue to be at a standstill, although merchant stocks are not yet exhausted.

Steel.

With a few additions to the number of rolling mills at work at part of their capacity, operating almost entirely, of course, on imported fuel, one hears of more frequent offers of British steel, but as yet the quantity available is necessarily extremely limited, and makers are asking substantial premiums on the minimum prices. In no section of the steel market during the past week, however, has there been much disposition on the part of users to place orders. The feeling seems to be fairly general that with a settlement of the coal dispute, by whatever means it is achieved, material should be obtainable at lower prices—lower, that is, than the prices they have been compelled to pay in order to fill their needs during the last few months. Since the increase reported last week continental makers have made no further alteration in quotations, although, in any case, they remain more or less nominal as orders are not being accepted with any degree of freedom yet, preference still being given to those orders on which buyers are prepared to pay bonuses so as to secure reasonably early delivery. The reported continental steel pact has not, as far as can be seen, created any perturbation among British steel makers. Prices of continental makes are already sufficiently low to attract those users who are prepared to wait for delivery and to accept the risk of faulty rolling and other incidental troubles of which complaints are not infrequently heard in connection with continental steels, whilst to increase the prices naturally narrows the margin which they already enjoy.

Scrap.

The demand for non-ferrous metal scrap is quiet, but prices seem steady all round. Scrap zinc, sorted and graded and delivered to users' works, is on offer at £25 to £26 per ton, scrap lead at £31, brazierv copper at £52, clean light copper at £57, heavy copper scrap at £62, heavy yellow brass at £45, and best selected gun-metal at £53. Iron and steel scrap is extremely quiet and prices remain nominal.

BARROW-IN-FURNESS.

Hematite.

There is no change in the position in this district. The position is simply that of waiting for a settlement in the coal dispute, so that fuel may be obtained regularly and permit the makers to start on a period of activity greater, it is hoped, than they experienced for many months before the stoppage. Orders are held for a good tonnage and makers will be engaged for many months dealing with them. As regards iron ore there is a little trade in it with customers outside the district, but very little ore is being dealt with, and this state of things will continue until the furnaces are in blast again. Foreign ore is not being imported, but as soon as business starts again there will be plenty of shipments into Barrow.

Steel.

The hoop works continue to turn out a fair amount of material and there was a heavy shipment the other week for abroad. There is nothing being done in other departments, but orders are held which will keep the mills going for a considerable time once they can start again.

Coal.

The port of Barrow continues to figure largely as an importer of coal, which is taken on moderate account locally and is being sent inland in fairly heavy bulk. The L.M.S. Railway has been taking a fair proportion.

SHEFFIELD.

(From our own Correspondent.)

Steel Trade Position.

ALTHOUGH disappointed by the breakdown of the latest Conference between the miners and the owners, the steel manufacturers and engineers of Sheffield and district are not disheartened or any more inclined to give up the fight. On the contrary they are renewing their efforts to overcome the difficulties which face them. Brown Bayleys Steel Works, Ltd., have restarted a 25-ton Siemens furnace, using foreign coal. It is intended to produce good quality steel of the sort that is now generally running out of stock. It is this shortage of steel that is still one of the greatest difficulties, but with fuel supplies becoming more plentiful every day other Sheffield and district firms may be induced to follow this local example, and also that of Middlesbrough, where, it is reported, three steel furnaces and a plate mill have been restarted on foreign coal. At a few works crucible steel is being melted, chiefly with Westphalian coke, which is proving very suitable. It is only the question of expense that is deterring the crucible steel makers generally from restarting. Considerable quantities of industrial coal—much, of course, of poor quality—is available, and foreign coal is now arriving in this district in a free manner. Certainly it is expensive, but many firms are keeping departments going with it, and there is a number of important contracts to be carried out regardless of the price that has to be paid for the necessary fuel. The local trade position may change rapidly for the better during the next few weeks should the Derbyshire and Nottinghamshire miners carry out their promise of returning to work on a wholesale scale. In this event the Sheffield and Rotherham works should begin to get supplies of better and cheaper fuel, and if such a source became assured steel makers would no doubt at once resume production. Numbers of orders are awaiting execution, and when work is fully resumed departments will be at full capacity for several months at least.

Engineering Departments.

The engineering departments would be a good deal busier if only they could get supplies of material, but a few works are in the fortunate position of producing as much material now as before the stoppage. The majority of departments, however, have had to restrict their activities. Railway plants are the busiest and some promising inquiries are in circulation from such good railway customers as India, South America, and South Africa. There is practically nothing being done in colliery, shipbuilding and armament work. Medium and lighter branches of engineering are more favourably placed. Automobile steel is in brisk request, and, on the whole, firms specialising in that branch have carried on remarkably well. The coal dispute has not interfered with the production of stainless steel, as the bulk of that material is melted in electric furnaces. This season has been exceptionally good for the makers of agricultural machinery, and the abundant harvest has resulted in a heavy call for spare parts. One of the most interesting orders recently announced, in which a local firm is concerned, is that placed by the London, Midland and Scottish Railway Company for thirteen Sentinel–Cammell steam rail passengers coaches. These, it is understood, are to be put into service on selected stations of main lines and also on railways serving sparsely populated areas in various parts of the country. Although the report of the year's trading of the Brightside Foundry and Engineering Company, Ltd., the well-known Sheffield firm, makes no comment on points of trade interest, the financial return is decidedly encouraging. The operations for the year to the end of June show an increase in net profit from £5568 to £9380, compared with the previous twelve months. This indicates a continuance of the recovery recorded in 1925.

Vickers Airship Experiment.

The statement by Sir Keith Smith, the representative of Vickers, Ltd., in Australia, that the firm hopes to conduct an experimental flight from England to Australia in 1928 with the airship it is building for the Government, has again drawn attention to this side of the great steel and engineering company's work. It may be of interest to recall some of the details of this airship. It is nearly two years since Sir Trevor Dawson announced at a gathering at the River Don Works, Sheffield, that Vickers had signed a contract with the Government for an airship of 5,000,000 cubic feet capacity, some 100 per cent. greater than that of the ZR3 which crossed the Atlantic from Germany to America. The following are the chief particulars of the airship:—Length overall, 695ft.; maximum diameter, 132ft.; gross lift, 152 tons; total power, 3850 horse-power—consisting of seven engines of, roughly, 600 horse-power each; air speed, 70 miles per hour; passengers carried, 120; crew, 40; range—with 50 per cent. reserve of fuel—2500 miles. The cost of the vessel was stated to be approximately £350,000.

The Lighter Trades.

All branches of the tool trades present optimistic reports, and the prospects of increased business with the Colonies are particularly good. Owing to the effect of exaggerated reports as to the extent that the coal stoppage is holding up production, a few houses have cancelled or withheld orders, but the majority have complete confidence in the ability of Sheffield firms to deliver the ordered goods to time. South Africa, Australia, New Zealand and Canada are all buying well of edge tools, files, saws, machine tools, and agricultural implements, though in the case of Canada rather severe American competition has to be faced. Manufacturing costs have necessarily risen during the last few months, but the selling prices that operated before the dispute still rule, from which it will be gathered that business at present is anything but profitable. This applies also to the plate and cutlery trades, the position of which is generally unchanged. Sheffield Chamber of Commerce draws attention in its monthly review to the fact that a United States Government trade bulletin on cutlery says that Sheffield is holding its own in Australia, is supreme in South Africa, in all kinds of cutlery, that in Canada we have most of the trade in table knives, but that in Argentine, Mexico and Brazil we are beaten by American and German competition. Another article in the Chamber's review states that the most unsatisfactory feature of the present situation is the extension of the practice of cheapening the prices of stainless knives by means of lowering the quality and marking them in a way which leads the buyers to believe that the goods are typical of Sheffield's best work. It is said that very inferior stainless cutlery is being exhibited in some of the good class London shops and ticketed at high prices.

Colliery Combine Proposals.

Considerable prominence was given in the Press last week to a statement that four of the best known colliery companies in South Yorkshire, Denaby and Cadeby, Dinnington, Maltby and Rossington—had virtually completed an arrangement for an amalgamation. Lord Aberconway is chairman of the Dinnington, Maltby and Rossington Collieries, and at the last meeting of the Dinnington Company he referred to the importance of combination. "The time has come," he said, "when the colliery interests must take some steps towards combination. We are faced with unexampled conditions in the trade. We know that in the report of the Coal Commission attention is called to the necessity of combinations, and the Government, I believe, is prepared to welcome any scheme of this nature. We have now, in conjunction with several of the largest firms in South Yorkshire, proposals for dealing with this question on equal lines." The statement that the amalgamation referred to above was "virtually complete" is denied in official quarters. Inquiries have been entered into with the object of ascertaining whether amalgamation was possible, but since then no substantial progress has been made.

NORTH OF ENGLAND.

(From our own Correspondent.)

No Sign of Resumption.

THERE is no sign of any general return to work on the part of the Northumberland and Durham miners. There are, of course, some non-federated collieries which have been working for the past few weeks, but it can be taken that the miners of the two counties, in the main will be the last to go back, unless the local Boards of Guardians cut off supplies, in which case anything might happen. It is quite certain that there is no starvation in the North-Eastern coalfield. The miners themselves are free to gamble and pursue their ordinary sporting avocations in the sure and certain knowledge that their wives are going to be looked after, whilst the children are certain to be better fed than if the miners were working full time. In such circumstances there is no incentive to the men to go down the pits. The coalowners have no good orders on the books and therefore they are not worrying themselves as to how long the stoppage lasts. To put it bluntly, the export mineowners are quite content to prove to foreign buyers that the dross supplied at high rates by German, Belgian, French and Czecho-Slovakian salesmen is far inferior to the good, honest fuel sold from English mines before the stoppage. Their determination to allow the lesson to sink in may not be good business from the point of view of the Northern merchants and exporters, but it may be the best policy in the long run for everybody concerned.

Cleveland Iron Trade.

The further setback to hopes of peace with the miners can only serve to intensify the shortage of all classes of pig iron and steel, and increase consumers' dependence upon outside sources of supply. A good deal of foreign iron is now being imported, and although continental prices tend to rise, they are still well below prices in this district, even with the addition of freight charges. Statistically, the Cleveland iron trade is in a very strong position. Stocks have been reduced to almost vanishing point, and when conditions admit of more furnaces being put into blast producers promise to be kept actively employed in overtaking arrears of deliveries against contracts that are unavoidably in abeyance. Prospects are thus regarded as far from discouraging. Meanwhile, however, both buyers and sellers continue to pursue a cautious policy, and business is confined to transactions to meet early requirements. Quotations are unchanged from last week, No. 1 Cleveland foundry iron being 92s. 6d., No. 3 G.M.B. 90s., No. 4 foundry 89s., and No. 4 forge 88s. 6d. per ton.

Hematite Pig Iron.

East Coast hematite is now somewhat scarce. With one exception producing firms have very little unsold stock and values are stiffening with the strengthening statistical situation, but are still on a very low level as compared with rates ruling for Cleveland pig iron. Mixed numbers of hematite are fully 82s. 6d., and No. 1 83s. per ton.

Ironmaking Materials.

Since the beginning of August there have been no imports of foreign ore, and not a single transaction is reported, but German coke is still being imported for the blast-furnaces at round about 36s. per ton c.i.f.

Manufactured Iron and Steel.

Two steel mills have been started this week in the Teesside district on special orders, but ordinary consumers of manufactured iron and steel find it almost impossible to cover their needs, and prices are more or less nominal. The galvanised sheet mills, using little coal, are still running, but foreign sheet bars are not so easily procurable. Makers' price for galvanised corrugated sheets, 24-gauge, is £17, and for black sheets £11 per ton.

Shipyard Work Held Up.

The coal stoppage is now having the effect of holding up what little amount of shipbuilding is in hand on the North-East Coast by the difficulty in getting delivery of steel plates and bars from manufacturers. Shipbuilders have not resorted to the use of foreign materials in substitution for English steel. Ship repairing is also suffering by many vessels being sent abroad for repairs when normally they might have been expected to be docked in this area for such work.

The Coal Trade.

Non-federated pits in both Northumberland and Durham are being worked by some hundreds of men and are doing very well. The men are on eight-hour shifts and are reported to be earning good wages, while the output is finding a ready sale on home account at prices much above the average. When the collieries resume work it is expected that there will be a brisk demand for a month or six weeks, but after that the prospects are likely to be uncertain on account of the competition from so many coal-producing countries. There is little mention of forward business, although it is said that cargoes of both Northumberland and Durham coals have been bought for shipment within a few weeks after the pits resume. For transactions of this kind values tend to greater firmness. Nominally best qualities of steam coals are round about 18s. and smalls at 11s. 9d. per ton.

SCOTLAND.

(From our own Correspondent.)

Position Unchanged.

THE general situation in Scotland is unchanged. In most trades production continues on a very restricted basis and appears likely to remain so for some time yet, probably for some weeks after a settlement of the coal strike has been reached. In some trades orders have accumulated and guarantee a good restart when the time arrives, but in others practically all operations have been suspended until the strike is over owing to the impossibility of anticipating the trend of prices when normal conditions are restored.

Glasgow Subway Cable.

The Tramways Committee of Glasgow Corporation had under consideration tenders for two haulage cables for the subway. The sub-committee on works and stores recommended the acceptance of an offer from R. S. Newall and Son, Ltd., Liverpool, to supply both ropes at a sum of £3115 5s. 5d. each and rejected an amendment that one cable should be ordered from Messrs. Newall and one from German manufacturers, the latter to cost £1684 16s. 9d. The Tramways Committee again carried the amendment and the Corporation will decide the matter this week.

Steel and Iron.

The position in the steel and iron trades is still dominated by the coal situation, and little change is noticeable. It is said that, provided there are no cancellations, the steel works have now sufficient orders on hand to guarantee a greater degree of activity than has been possible for some time past. Any steel bars and sections available find a ready sale at firm prices. Black and galvanised sheets are fully maintained and prices will probably touch a still higher level. There is no activity in heavy steel apart from anything that can be supplied from stock. Bar iron shows a decidedly upward tendency in price.

Pig Iron.

Business in pig iron is more or less at a standstill. Supplies of some varieties are almost impossible to obtain, production having been discontinued. Prices vary somewhat, but are all firm.

Coal.

There is not much change in the coal situation In most districts the miners have shown a tendency to return to work, but the number actively engaged is very small. In a number of cases successful picketing has prevented many men from working. Arrivals of foreign coal are still considerable. The steamer Elenardle arrived at Glasgow Harbour from Hampton Roads a few days ago with 6700 tons of best screened coal, purchased on behalf of the British Government. The congestion of arrivals at Grangemouth has been relieved somewhat, but is still pronounced. The market for foreign coal has fluctuated lately. On the breakdown of negotiations in London the demand for foreign fuel revived, but conditions became unsettled again when reports of men returning to work in large numbers began to come through. In some cases importers with commitments abroad have experienced difficulty in arranging forward sales and also in disposing of full cargoes which have arrived within the past few days. Public utility works and household consumers constitute the main sources of disposal, commercial demands being few and far between.

WALES AND ADJOINING COUNTIES.

(From our own Correspondent.)

The Coal Outlook.

NOTWITHSTANDING the fact that the meeting between the miners' leaders and the coalowners last week ended in a deadlock the feeling is growing that the end of the coal stoppage in this country is within sight. Whether that is the case in South Wales is rather a moot point, as the position is very difficult to gauge. Reports are coming to hand that it only requires a few men in the different areas to make a start and thousands of other miners will follow. In some of the outlying areas a few men have gone back, and on Saturday last just over 200 men signed on for work at pits belonging to the Powell Duffryn Company in the Rhymney Valley, but doubtless as the result of meetings over the week-end they did not actually recommence work on Monday, though the report is current that they made a start on Tuesday. Miners' leaders and extremists are doing their utmost to restrain workmen from breaking away, and are urging them to fight to a finish. Mr. Noah Ablett, a member of the executive of the M.F.G.B., who at the recent Federation Conference in London seconded the resolution in favour of the reopening of negotiations, has announced that he has definitely changed his policy to one of fighting it out. In the Rhymney Valley district it is reported that practically the whole of the lodges have communicated with the district office of the South Wales Miners' Federation, urging that the central executive should take action with a view to withdrawing the safety men from the mines. As against this it will be interesting to see what the effect will be of the action of the general manager of the Ocean Collieries in sending a circular letter to all the miners employed by the company in which he makes a strong appeal to the men to consider the proposals made to them in a spirit of comradeship. The relations between the men and this undertaking have always been of the best possible character. The general manager explains the position most lucidly, and after stating that with an excellent market commodity, a lower cost of production and goodwill all round their rate of wages can be maintained and possibly raised at the end of three months, he adds that the present dispute demonstrates once more the futility of endeavouring to settle matters by a resort to force.

Strike Effects.

Evidence is forthcoming that during the last fortnight the effects of the coal strike have become more severely felt in all directions of trade. In all the principal towns of this district, except the mining areas proper, there has really been little to remind one of the grim struggle which has been proceeding, but of late complaints of bad trade have become very rife and most of all it is reported that money is very short. At the docks the ship-repairing industry has continued to be very quiet at all the centres, with the exception of Cardiff, where the principal firms have had one or two very useful orders. Were it not for the importation of coal, employment at the docks would be very dull, as imports have rather fallen off compared even with what they were a week or so ago, except in the case of partly manufactured iron and steel goods. Even coal is not coming in on such an active scale. The number of steamers which have been discharging have varied from about fifteen to twenty, and there are, of course, other cargoes to come along. At the same time, in view of the more hopeful outlook regarding a termination of the strike, those who are engaged in the importation of coal from the Continent and America are adopting a very cautious policy so as not to be left with cargoes on their hands which they cannot sell. So far the coal imported from abroad into South Wales amounts roughly to half a million tons.

Miners' Return.

It is understood that only thirty-three men returned to work at the New Tredegar and Elliot Colliery in the Rhymney Valley on Tuesday, whereas just over 200 signed on for work in Saturday. Some of them received unpleasant attentions from other miners and women folk who are opposed to their working, and police have had to protect them. The thirty-three miners did not put in an appearance for work on Wednesday.

Tin-plate Trade.

Fully 30 per cent. of the tin-plate works are operating, but business is on the quiet side. Stock plates have been sold up to 24s. basis, I.C. f.o.b. works port, but very little is being done for shipment after the coal stoppage, sellers asking from 20s. to 21s. basis.

Craftsmen's Agreement Repudiated.

The colliery enginemen, stokers and craftsmen's section of the South Wales Miners' Federation at Merthyr on Wednesday passed a resolution repudiating the agreement recently entered into by the South Wales and Monmouthshire Colliery Enginemen, Boilermen and Craftsmen's Association with the coalowners, which involves an eight-hour working day.

Traffic Returns.

The Great Western Railway Company has now issued its returns of trade for the ports of Cardiff, Swansea, Newport, Barry, Port Talbot and Penarth, and they show that from January 1st to August 8th of this year imports and exports amounted to 14,924,380 tons, which compares with 21,998,305 tons for the corresponding period of last year. Exports alone came to 11,869,743 tons, as against 18,769,707 tons for the same period of 1925. The chief reduction has, of course, been in coal and coke. Exports of these two commodities for the period in question amounted to 10,087,229 tons, whereas for the same period of last year the total was 16,740,125 tons. The falling off in coal and coke is therefore 6,652,896 tons.

Burry Port Developments ?

Rumours are current regarding possible big developments to the advantage of Burry Port and district. The Pembrey Munition Works and their future are the subject of considerable speculation. These works were erected by the Ministry of Munitions during the war, and cover an area of over 700 acres on the foreshore of Pembrey. The report is current that a big English concern is negotiating for the property, and that it has a big scheme in hand which, if it materialises, will mean employment for thousands of men. There is, however, no confirmation of the rumours.

CATALOGUES.

F. PRATT AND CO., Ltd., Halifax.—Illustrated price list of the various types and sizes of chucks made.

FERRANTI, Ltd., Hollinwood, Lancs.—Pamphlet W.b. 401, describing the firm's patented audio frequency transformers.

MARSHALL, SONS AND CO., Ltd., Gainsborough.—Publication No. 1646, giving a detailed description of the "Marshall" road roller.

ALGERNON LEWIN CURTIS, Chatteris.—Illustrated catalogue of sands, clays and economic materials for all industrial purposes.

HADFIELDS, Ltd., East Hecla and Hecla Works, Sheffield.—Leaflet No. 229, describing the runaway tub catch (Ball's patent) for use in mines.

SPENCER-BONECOURT, Ltd., Parliament Mansions, Victoria-street, S.W. 1.—Form No. 221-26, illustrating and describing gas-fired boilers and water heaters.

STEVENS AND STANSFELD, Sentinel House, Southampton-row, W.C. 1.—Brochure containing facts about the "Traberg" electric boiler scaling and rust-removing apparatus.

THE CEMENT MARKETING COMPANY, Ltd., Portland House, Tothill-street, S.W. 1.—Brochure entitled "Ferrocrete, the Rapid Hardening Portland Cement," illustrating and describing the uses of and advantages obtainable from "Ferrocrete."

CONTRACTS.

GUEST AND CHRIMES, Ltd., Rotherham, have received an order to supply and erect the valve shaft fittings at the More Hall compensation reservoir of the Sheffield Corporation Ewden Valley Waterworks.

CLAYTON WAGONS, Ltd., Lincoln, has recently received an order from the Forden Rural District Council, Garthmyl, Montgomeryshire, for a 4/5-ton "Clayton" overtype steam wagon with three-way tipping body.

THE GREAT WESTERN RAILWAY COMPANY announces that the following contracts have been placed:—(*a*) Repairs to hydraulic economiser, Swansea Docks, E. Green and Son, Ltd., Wakefield; (*b*) overhaul of steam tug St. Baruch, the Penarth Pontoon Company, Ltd., Cardiff; (*c*) overhaul of steam tugs Lady Tredegar and Emily Charlotte, Thomas Diamond and Co., Ltd., Bute Docks, Cardiff; (*d*) overhaul of ss. Smeaton, the Bickle Engineering Company, Plymouth; (*e*) supply of four electric trollies for Queen Alexandra Dock warehouse, Cardiff, Electromobile, Ltd., Prospect Works, Otley, Yorks., and Ransomes, Sims and Jefferies, Ltd., Orwell Works, Ipswich; (*f*) repainting of spare lock gates at King's Dock, Swansea, Wailes, Dove, Bitumastic, Ltd., 1, Billiter-avenue, London, E.C. 3; (*g*) supply of two electrically-driven pressure pumps at Reading, Fielding and Platt, Ltd., Gloucester; (*h*) supply of bulk storage petrol plants at Slough and Saltash, Milwaukee Tank Works, Inc., Abbey House, Westminster, S.W. 1; and *j*) reconstruction of bridge, road improvements, &c., at Aberbeog, Mr. J. M. Broadfoot, Woodland Park-road, Newport, Mon.

PERSONAL AND BUSINESS ANNOUNCEMENTS.

DOWDINGS' MACHINE TOOL COMPANY, Ltd., of Bush House, Aldwych, London, W.C. 2, has been appointed sole selling agent in Great Britain and the British Dominions overseas for the Oerlikon Machine Tools Works, of Switzerland.

REGULATIONS FOR THE ELECTRICAL EQUIPMENT OF SHIPS.—The Council of the Institution of Electrical Engineers has revised the I.E.E. regulations for the electrical equipment of ships and has authorised the publication of a second edition. Copies may be obtained from the Secretary of the Institution, Savoy-place, W.C. 2, or from E. and F. N. Spon, Ltd., 57, Haymarket, S.W. 1.

MAGNESIAN FLOORING MATERIALS ASSOCIATION.—We are asked to draw attention to the fact that the Magnesian Flooring Materials Association has been formed for the purpose of developing and increasing the use of magnesian compositions for all purposes, such as jointless flooring, ships' decks, stucco work, plaster work, &c. The Association is also co-operating with recognised organisations of research and investigations for the purpose of improving and standardising magnesian compositions, promoting exchange of views between manufacturers for the purpose of determining the best method of manufacturing, &c. Any persons or firms having interest in the materials are invited to correspond with the secretary at the offices of the Association, 106, Fenchurch-street, London, E.C. 3.

RAILWAY STATISTICS FOR MAY.—The railway statistics for May, 1926, have now been published by the Ministry of Transport and can be obtained at his Majesty's Stationery Office, price 3s. 6d. The figures are affected by the general strike and the stoppage in the coal mining industry. The total number of passenger journeys—excluding season ticket holders—taken in May, 1926, was 52,352,539, a decrease compared with May, 1925, of 47,914,865, or 47·8 per cent. The receipts from passengers—excluding season ticket holders—showed a decrease of £2,161,811, or 40·7 per cent. If the London tubes and Metropolitan District Railway be omitted the figures show a decrease in journeys of 40,832,937, or 51·1 per cent., and a decrease in receipts of £2,071,108, or 41 per cent. For all companies the receipts from passenger train traffic—including season tickets and parcels and miscellaneous traffic, but excluding mails and parcels post—were £2,721,073 less than in May, 1925, a decrease of 36·8 per cent. The coaching train miles showed a decrease of 11,519,059, or 53·7 per cent. The total tonnage of freight conveyed—excluding free-hauled traffic—was 5,893,810, a decrease of 20,919,457, or 78 per cent. The total ton-miles—excluding free-hauled—were 69·2 per cent. less than in May, 1925. Freight train receipts—less cost of collection and delivery—amounted to £3,286,981, a decrease of £5,327,875, or 61·8 per cent. The freight train miles run were 7,781,376 less than in May, 1925, equivalent to a decrease of 66·2 per cent.

Current Prices for Metals and Fuels.

IRON ORE.

N.W. Coast—	
Native	18/6 to 21/-
(1) Spanish	18/6 to 21/-
(1) N. African	18/6 to 21/-
N.E. Coast—	
Native	—
Foreign (c.i.f.)	21/6

PIG IRON.

	Home. £ s. d.	Export. £ s. d.
(2) Scotland—		
Hematite	4 2 6	—
No. 1 Foundry	4 15 0	—
No. 3 Foundry	4 10 0	—
N.E. Coast—		
Hematite Mixed Nos.	4 2 6	4 2 6
No. 1	4 3 0	4 3 0
Cleveland—		
No. 1	4 12 6	4 13 0
Silicious Iron	4 12 6	4 13 0
No. 3 G.M.B.	4 10 0	4 10 6
No. 4 Foundry	4 9 0	4 9 6
No. 4 Forge	4 8 6	4 9 0
Mottled	4 8 0	4 8 6
White	4 8 0	4 8 6
Midlands—		
(3) Staffs.—		
All-mine (Cold Blast)	10 10 0	—
North Staffs. Forge	3 17 6	—
,, ,, Foundry	4 7 6	—
(3) Northampton—		
Foundry No. 3	3 5 0 to 3 10 0	
,, Forge	2 16 0 to 2 17 0	
(3) Derbyshire—	(*None offered.*)	
No. 3 Foundry	3 7 6 to 3 15 0	
Forge	3 2 0 to 3 5 0	
(3) Lincolnshire—	(*None offered.*)	
No. 3 Foundry	3 8 0	—
No. 4 Forge	3 5 6	—
Basic	3 6 0	—
(4) N.W. Coast—		
N. Lancs. and Cum.—		
Hematite Mixed Nos.	4 8 6 (*a*) / 4 12 0 (*b*) / 4 16 0 (*c*)	—

MANUFACTURED IRON.

	Home. £ s. d.	Export. £ s. d.
Scotland—		
Crown Bars	11 10 0 to £12	11 0 0
Best	—	—
N.E. Coast—		
Common Bars	11 5 0	—
Lancs.—		
Crown Bars	11 10 0	—
Second Quality Bars	10 5 0	—
Hoops	14 0 0	—
S. Yorks.—		
Crown Bars	12 10 0	—
Best Bars	13 10 0	—
Hoops	14 10 0	—
Midlands—	(*Prices nominal.*)	
Crown Bars	11 5 0 to 11 10 0	
Marked Bars (Staffs.)	14 0 0	—
Nut and Bolt Bars	10 5 0 to 10 10 0	
Gas Tube Strip	12 10 0	—

STEEL.

	(6) Home. £ s. d.	(7) Export. £ s. d.
(5) Scotland—		
Boiler Plates	11 0 0	—
Ship Plates, ½in. and up	7 17 6	7 0 0
Sections	7 7 6	6 5 0
Steel Sheets, under 3/16in. to ½in.	11 5 0 to 12 5 0	
Sheets (Gal. Cor. 24 B.G.)	— £17 5 0 to £18 5 0	

STEEL (*continued*).

	Home. £ s. d.	Export. £ s. d.
N.E. Coast—		
Ship Plates	8 0 0	—
Angles	7 10 0	—
Boiler Plates	11 10 0	—
Joists	7 10 0	—
Heavy Rails	8 10 0	—
Fish-plates	12 0 0	—
Channels	10 5 0	£9 to £9 5
Hard Billets	8 2 6	—
Soft Billets	7 5 0	—
N.W. Coast—		
Barrow—		
Heavy Rails	8 0 0†	—
Light Rails	8 5 0 to 8 10 0	
Billets	8 0 0 to 11 10 0†	
Manchester—		
Bars (Round)	9 5 0	—
,, (Small Round)	10 0 0	—
Hoops (Baling)	11 0 0	11 0 0
,, (Soft Steel)	10 15 0	10 15 0
Plates	8 2 6	—
,, (Lancs. Boiler)	11 10 0	—
Sheffield—		
Siemens Acid Billets	10 0 0	—
Bessemer Billets	11 0 0	—
Hard Basic	8 12 6	—
Intermediate Basic	8 2 6	—
Soft Basic	7 5 0	—
Hoops	12 0 0	—
Soft Wire Rods	9 10 0	—
Midlands—		
Small Rolled Bars	7 15 0 to 8 10 0	
Billets and Sheet Bars	6 2 6 to 6 7 6	
Sheets (20 W.G.)	11 10 0 to 12 0 0	
Galv. Sheets, f.o.b. L'pool	17 0 0 to 17 10 0	
Angles	7 7 6 to 8 17 6	
Joists	7 7 6 to 8 17 6	
Tees	8 7 6 to 9 17 6	
Bridge and Tank Plates	7 17 6 to 8 15 0	
Boiler Plates	11 0 0 to 11 15 0	

NON-FERROUS METALS.

Swansea—	
Tin-plates, I.C., 20 by 14	20/- to 24/6
Block Tin (cash)	291 12 6
,, (three months)	286 10 0
Copper (cash)	58 15 0
,, (three months)	59 10 0
Spanish Lead (cash)	32 8 9
,, (three months)	32 1 3
Spelter (cash)	34 3 9
,, (three months)	34 10 0
Manchester—	
Copper, Best Selected Ingots	66 17 6
,, Electrolytic	67 15 0
,, Strong Sheets	90 0 0
,, Tubes (Basis Price)	0 1 1
Brass Tubes (Basis Price)	0 1 0
,, Condenser	0 1 2½
Lead, English	34 10 0
,, Foreign	32 10 0
Spelter	34 12 6

FERRO ALLOYS.

(*All prices now nominal.*)

	Per Ton.	Per Unit.
Tungsten Metal Powder	1/10½ per lb.	
Ferro Tungsten	1/5 per lb.	
Ferro Chrome, 4 p.c. to 6 p.c. carbon	£22 10 0	7/6
,, 6 p.c. to 8 p.c. ,,	£22 0 0	7/3
,, 8 p.c. to 10 p.c. ,,	£20 15 0	6/6
,, Specially Refined		
,, Max. 2 p.c. carbon	£38 10 0	12/6
,, ,, 1 p.c. ,,	£44 10 0	15/-
,, ,, 0·70 p.c. carbon	£54 10 0	17/6
,, ,, carbon free	1/5½d. per lb.	
Metallic Chromium	3/3 per lb.	
Ferro Manganese (per ton)	£15 for home, £15 for export	
,, Silicon, 45 p.c. to 50 p.c.	£10 7 6 scale 5/- per unit	
,, ,, 75 p.c.	£20 10 0 scale 6/- per unit	
,, Vanadium	15/- per lb.	
,, Molybdenum	5/9 per lb.	
,, Titanium (carbon free)	0/11 per lb.	
Nickel (per ton)	£170	
Cobalt	10/- per lb.	
Aluminium (per ton)	£112	

FUELS.

SCOTLAND.

(*Prices nominal.*)

	Export.
Lanarkshire—	
(f.o.b. Glasgow)—Steam	15/9
,, ,, Ell	16/6
,, ,, Splint	16/6 to 17/-
,, ,, Trebles	15/9
,, ,, Doubles	14/- to 14/6
,, ,, Singles	13/9
Ayrshire—	
(f.o.b. Ports)—Steam	16/9
,, ,, Jewel	17/- to 17/6
,, ,, Trebles	17/-
Fifeshire—	
(f.o.b. Methil or Burntisland)—Steam	12/6 to 14/9
Screened Navigation	21/-
Trebles	14/- to 15/-
Doubles	14/-
Singles	13/- to 13/6
Lothians	
(f.o.b. Leith)—Best Steam	14/- to 14/3
Secondary Steam	13/6
Trebles	14/6 to 14/9
Doubles	13/6
Singles	13/6

ENGLAND.

(8) N.W. Coast—	
Steams	*No quotation.*
Household	,, ,,
Coke	,, ,,
Northumberland—	
Best Steams	16/-
Second Steams	14/6 to 15/-
Steam Smalls	8/- to 8/6
Unscreened	13/- to 13/6
Household	20/- to 22/-
Durham—	
Best Gas	18/6 to 19/-
Second	15/- to 15/6
Household	20/- to 22/-
Foundry Coke	18/- to 20/-

Sheffield	Inland. (*Nominal: none on offer.*)
Best Hand-picked Branch	31/- to 34/- —
Barnsley Best Silkstone	28/- to 30/- —
Derbyshire Best Brights	26/- to 28/- —
,, ,, House	24/- to 25/- —
,, ,, Large Nuts	17/- to 20/- —
,, ,, Small	12/6 to 14/- —
Yorkshire Hards	17/- to 19/6 —
Derbyshire Hards	16/- to 19/- —
Rough Slacks	10/- to 12/6 —
Nutty Slacks	7/6 to 9/- —
Smalls	3/6 to 6/- —
Blast-furnace Coke (Inland)*	— —
,, ,, (Export)	f.o.b. 16/- to 17/

(9) SOUTH WALES.

(*All prices nominal.*)

Cardiff—	
Steam Coals:	
Best Smokeless Large	26/- to 27/-
Second ,, ,,	24/6 to 25/6
Best Dry Large	24/- to 25/-
Ordinary Dry Large	21/- to 22/-
Best Black Vein Large	25/6 to 26/-
Western Valley Large	24/6 to 25/-
Best Eastern Valley Large	24/- to 25/-
Ordinary ,, ,,	23/6 to 24/-
Best Steam Smalls	17/- to 18/-
Ordinary ,,	16/- to 17/-
Washed Nuts	19/- to 26/-
No. 3 Rhondda Large	26/6 to 27/-
,, ,, Smalls	18/- to 18/6
No. 2 ,, Large	24/- to 25/-
,, ,, Through	20/- to 21/-
,, ,, Smalls	15/- to 16/-
Foundry Coke (export)	40/- to 50/-
Furnace Coke (export)	25/- to 30/-
Patent Fuel	42/6 to 45/-
Pitwood (ex ship)	26/6 to 27/6
Swansea—	
Anthracite Coals:	
Best Big Vein Large	39/- to 40/-
Seconds	32/6 to 35/-
Red Vein	27/- to 29/-
Machine-made Cobbles	47/6 to 50/-
Nuts	47/6 to 50/-
Beans	42/6 to 44/-
Peas	23/- to 25/-
Breaker Duff	7/6 to 8/-
Rubbly Culm	12/6 to 13/6
Steam Coals:	
Large	22/6 to 24/6
Seconds	20/- to 22/-
Smalls	11/- to 15/-
Cargo Through	16/6 to 17/6

(1) Delivered. (2) Net Makers' works. (3) f.o.t. Makers' works, approximate. (4) Delivered Sheffield. (5) Glasgow, Lanarkshire and Ayrshire.

(6) Home Prices—All delivered Glasgow Station. Boiler Plates 10/- extra delivered England. (7) Export Prices—f.o.b. Glasgow. (8) Except where otherwise indicated, coals are per ton at pit for inland and f.o.b. for export, and coke is per ton on rail at ovens and f.o.b. for export. (9) Per ton f.o.b. * For blast-furnaces only, 17/-, with fluctuations according to analysis; open market 17/6 to 19/- at ovens † Latest quotations available. (*a*) Delivered Glasgow. (*b*) Delivered Sheffield. (*c*) Delivered Birmingham.

French Engineering Notes.

(From our Correspondent in Paris.)

The Steel Union.

THE secrecy which was observed over the proceedings at the recent meeting in Paris of French, German, Belgian and Luxemburg delegates to settle the final details for the constitution of the European Steel Union naturally gave rise to many rumours as to why it was found necessary to postpone further the discussion until next month. The statements from Germany to the effect that the French group wanted a larger share of the foreign trade than it was entitled to do not appear to have been borne out by facts, for the respective quotas of the countries interested had already been fixed upon, and it was hardly to be expected that the French would reopen the question of participation at the last moment. In Belgium it was stated that the negotiations had fallen through altogether, and there again the statement was obviously belied by the fact that the meeting had been postponed to a fixed date. The reason for the postponement was the difficulty of coming to an understanding amongst groups over complicated interests, when some of those groups are so lacking in organisation that all the various members have to be consulted individually on important points before it is possible to come to a decision. That is the case with the Belgians, who have not yet been able to settle upon the way in which their quota of trade is to be divided up amongst themselves, and until there is absolute agreement on those points it is impossible to sign the statutes of the new organisation. It is believed that the Paris meeting was postponed one month merely to give the Belgian delegates an opportunity to consult the members of their group. If it were not for the holiday season this long postponement would not have been necessary.

Limiting the Steel Output.

The only question remaining to be settled, outside matters affecting individual interests, is the limitation of the steel production. It is declared that there is no intention of limiting production with a view of increasing steel prices. Those prices, reduced to a gold basis, are still relatively below the pre-war level, and consumers are said to have no reason to complain of the steady hardening of prices which is now taking place, and will probably accentuate, without such prices reaching an unjustified or inflated figures. It is proposed to take as a basis the highest production yet recorded, either the figures for 1925 or those for the first six months of 1926. That proposal is giving rise to some discussion, as the adoption of one or the other would make an appreciable difference to the quantities to be allotted to certain countries. In France, for instance, the production of raw steel during the first six months of the present year was 4,060,705 tons, as compared with 3,567,367 tons in the similar period of 1925. At the same time the pig iron production was 4,570,092 tons, as against 4,090,990 tons. The interests involved are so complicated and conflicting that a settlement of all the main points of an agreement is, in itself, a remarkable achievement, and if the Belgian steelmakers can agree to their own individual participation it is fairly certain that the Steel Union will be definitely constituted next month.

Coal Markets.

The conditions of coal production on the Continent have changed so completely of late years that there are no longer any markets in which British coal can claim a monopoly. The heavy decline in the importation of British coal into France is a characteristic phase of the situation, and the Italian purchases of more than ten million tons a year are now made more extensively in other countries, where arrangements are being made to insure permanent supplies to the detriment of the British trade. The Italian railways employ German coal, which is supplied on account of reparations, and until 1924 the deficiency was made up with coal purchased in Cardiff; but since then arrangements have been made to increase the consignments of German coal and, at the same time, to obtain further supplies from Upper Silesia. As is the case with the German fuel, the Polish consignments arrive both by rail and by sea, and agreements are now being made with the various countries of transit whereby special rates are applied for the carriage of coal, with the result that the freights by rail from Upper Silesia to the Italian frontier are less than the sea freights from Cardiff. The United States and the Saar are each sending about half a million tons a year to Italy, and negotiations are now being carried out for developing the Italian participation in the Russian colliery industry, which, it is believed, will supply considerable quantities of coal to Italy in the future. These efforts to render Italy independent of British coal supplies must be taken seriously into account by British coalowners, who find that they can only hope to maintain a fair share of the business in face of keen foreign competition. This means that colliers as well as owners will have to make sacrifices if the foreign trade is not to be definitely lost.

Unemployment.

It was expected that the slowing down of business activity as the result of the financial difficulties would have had the effect of throwing a large number of men out of employment, and the Minister of Labour has therefore found it necessary to publish figures showing that there is practically no unempoyment in this country at all. As a matter of fact, the lack of labour is so great that an organised service has had to be maintained for the immigration of foreign workmen, particularly Polish, the number of whom is now something like three millions. Every encouragement is offered to these working families to settle down permanently in France. Should the country experience an acute period of unemployment it will be a serious matter to know what to do with the foreign population. While everyone can find work in France, the unemployment figures in other countries are steadily increasing, not only in Germany but also in Austria, Poland and elsewhere, and it is feared that the situation generally will become critical unless something is done speedily to readjust the economic conditions of Europe.

British Patent Specifications.

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

Copies of Specifications may be obtained at the Patent Office, Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., at 1s. each.

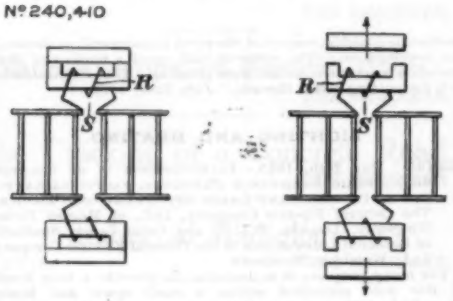
The date first given is the date of application; the second date, at the end of the abridgment, is the date of the acceptance of the complete Specification.

DYNAMOS AND MOTORS.

240,410. June 10th, 1925.—IMPROVEMENTS IN SELF-STARTING ASYNCHRONOUS MOTORS, Bayerische Elektricitäts-Werke, of Landshut, Bavaria, Germany.

Armatures for asynchronous motors with two secondary windings have been proposed by Boucherot. The running windings have a low ohmic resistance and a high reactance, while, on the other hand, the starting winding has a low reactance and a high ohmic resistance. The impedance of both the secondary circuits due to the arrangement of slots and the ohmic ratios of the secondary windings of Boucherot results, the inventors claim, in a very low power factor under normal running conditions, and thus, for any given model, only a low output, in proportion to the size of the motor, is obtainable. The object of this invention is to eliminate these disadvantages, and this is done by making the impedance of the secondary circuits with the low ohmic resistance variable and increasing it on starting, but reducing it to a low value for normal running. This considerably reduces the leakage, during normal running, and brings the power factor up to a value which is usual in short-circuit or slip-ring rotors. A further advantage of this arrangement resides in permitting free choice of the local positions of both the secondary windings, as the increase in the impedance of the

Nº 240,410

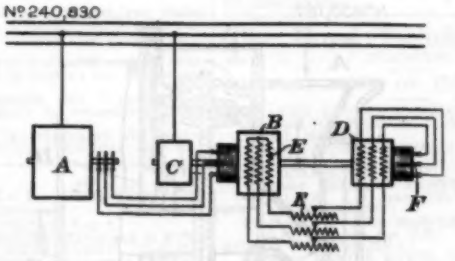


running winding at starting is not brought about, as in the case of Boucherot's rotor, by the position of the running winding in the active iron of the secondary portion. The impedance of the running winding is varied by varying the magnetic path of the whole circuit or a portion thereof. For this purpose it is provided with an iron yoke which can be wholly or partially removed by hand or automatically, as, for instance, by the action of centrifugal force. The starting winding in all cases exhibits a low reactance and high ohmic resistance, in order to increase the starting torque. The secondary circuits may be arranged either in the stationary or in the movable part of the motor. The drawings show diagrammatically the arrangement of a running winding, constructed as a squirrel-cage winding, with variable impedances R arranged across the points of separation S of the short-circuiting rings. The left illustration shows the arrangement at starting and the right that during normal running. Machines made according to the invention may be provided with any of the well-known devices for compensating phase displacement.—*July 22nd*, 1926.

240,830. September 29th, 1925.—IMPROVEMENTS IN OR RELATING TO CASCADE CONNECTED COMMUTATOR MACHINES FOR ASYNCHRONOUS INDUCTION MACHINES, Siemens-Schuckertwerke Gesellschaft mit beschrankter Ha tung, of Berlin-Siemensstadt, Germany.

For the phase compensation of the induction motor A the electrically coupled cascade connected commutator machine B is employed. C is the driving machine for the cascade-connected commutator machine. On the shaft of this machine there is a series three-phase alternating-current generator D, which, by self-excitation, feeds the exciting winding E of the cascade-connected machine. The frequency of the voltage delivered by the generator D may be controlled by adjustable resistances E, which are connected between the winding E and the generator D. The frequency of this voltage can, however, be controlled by shifting the brushes in the generator D. By regulation of the resistances E or of the positions of the brushes F, it is also possible

Nº 240,830



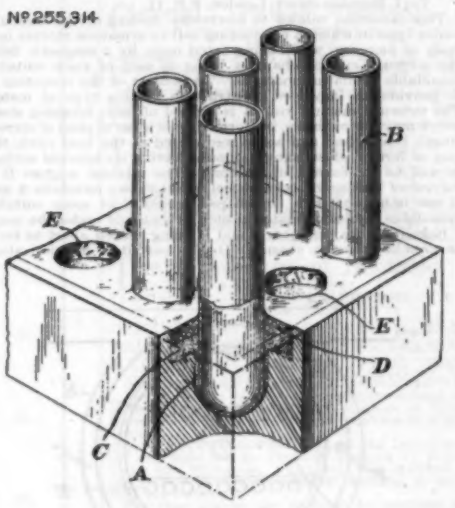
to regulate within certain limits the number of revolutions of the main machine. The frequency of the voltage delivered by the machine D normally adjusts itself to the correct value for the cascade-connected commutator machine, since the secondary current of the machine A flowing in the rotor of the cascade-connected machine affects the winding E in the sense of tending to produce a synchronisation of the rotating field due to the winding E or the generator D, with the field produced in the rotor of the cascade-connected machine by the secondary current. The cascade-connected machine B may have in the stator a compensating winding for suppressing the rotor ampère turns originating from the load current of the main motor. The advantage of this is that the phase compensation is completely independent of the load current of the main motor. The phase compensation can in this case be more easily adjusted to any desired value.—*July 22nd*, 1926.

BATTERIES AND ACCUMULATORS.

255,314. December 22nd, 1925.—IMPROVEMENTS IN OR RELATING TO ELECTRIC SECONDARY BATTERIES, Batteries, Ltd., and Allan Levin, all of Hunt End Works, Crabbs Cross, Redditch, Worcestershire.

This invention relates to electric secondary batteries, particularly to small capacity secondary batteries for use as the source of high tension in wireless and like installations. The stand or support is preferably composed of some moulded insulating material, and is formed with a number of holes, of which one is shown at A, to accommodate round-bottomed glass tubes B. The diameter of the hole is sufficiently large to allow some clearance between the wall of the hole and the outside of the tube B. This is convenient, as a number of glass tubes nominally of the same diameter often vary in diameter slightly. The tubes are first placed in the holes or recesses, so that they rest on the bottom and a layer C of sand or other finely

Nº 255,314



divided material—such, for instance, as fine sawdust—is placed round them. Some of this material will naturally fall down the clearance spaces between the tubes and the walls of the holes, and this serves to centre the tubes and hold them temporarily in position. Molten pitch or similar material is then poured into the stand to form a layer D round all the tubes. This, when set, holds the tubes firmly and permanently in place. Owing to the presence of the sand the molten pitch will not run down to the bottom of the tubes, and thus they are not actually stuck or cemented to the inside of the holes or recesses, but are merely held in place by the adhesion of the layer of pitch to the annular portions of the tubes with which the pitch comes into contact. At E there is an opening in the layer D of pitch from which one of the tubes has been removed. This operation can be very readily performed by passing over the tube a slightly larger metal tube to act as a cutter or having its lower edge heated sufficiently to melt the pitch round the particular tube to which it is applied.—*July 22nd*, 1926.

ELECTRICAL APPLIANCES.

250,606. April 8th, 1926.—IMPROVEMENTS IN AND RELATING TO PROTECTIVE ARRANGEMENTS FOR RECTIFIER SUBSTATIONS, *International General Electric Company, Inc., of 120, Broadway, New York, United States of America.*

It frequently happens that all the rectifiers in a sub-station do not come into operation simultaneously, ignition being effected more quickly in one rectifier than in another. Consequently, with n parallel connected rectifiers, it might happen that one of them was loaded n times its normal amount. This disadvantage is remedied, according to this invention, by arranging switch devices on the direct-current side of the rectifiers which are capable of connecting the rectifiers to the system only when all the rectifiers have lighted. In the drawing the rectifiers are

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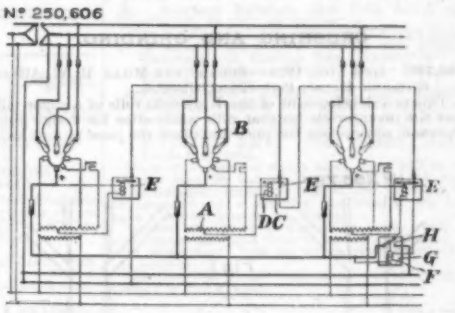


indicated by B, and their exciting circuits by A. In each of the exciting circuits there is a relay C, which controls contacts E. The winding D of each relay can only be excited when its associated rectifier has ignited. G is the main switch arranged in the connecting line between the distribution system and the rectifiers. The control coil F of this switch is connected in series with the contacts E, so that it receives current only when all the contacts E are closed, that is, when all the rectifiers have ignited. The energising of coil F operates the switch G and connects the rectifiers to the distribution system by way of contacts H.—*July 22nd*, 1926.

TRANSMISSION OF POWER.

255,256. September 3rd, 1925.—IMPROVEMENTS IN ELECTRIC CABLES, St. Helens Cable and Rubber Company, Ltd., of Slough, Buckinghamshire, and Herbert Evans, of Trading Estate, Slough, Buckinghamshire.

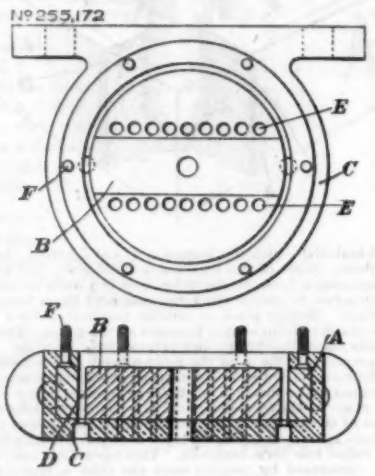
This invention relates more particularly to improvements in flexible cables in which, in addition to the usual insulating covering and tough rubber compound sheathing, there is provided a braided or similar metallic sheathing which may be used for earthing. Instead of employing in the manufacture of such cables a braided wire sheathing, a lapping formed of wire cloth of fine mesh or flat braided cloth is used, which, in the formation of the cable, may be wrapped in helices around the inner shell of tough rubber compound or, if no inner shell of tough rubber is provided, around the insulated conductors individually or as a whole. One of the central conductors may be a bare conductor and used for earthing purposes. Such a cloth does not fray out as a braid when worn. The flexible cable

thus suitably comprises a central conductor or conductors, all, or all but one, of which may be provided with surrounding insulation, and, if desired, a sheathing of tough rubber compound, then with a lapping of wire cloth of fine mesh, as distinguished from a braided or similar metallic sheathing, and a tough rubber compound surrounding the wire cloth lapping, the whole being vulcanised together. The fine meshed wire cloth may be employed in repairing a cable fitted with braiding or with lappings of wire cloth, and is much more satisfactory for the purpose than a braided sleeve, since it need only be wrapped around the broken ends of the wire sheathing and attached at each end to the sheathing.—*July 22nd*, 1926.

MEASURING AND TESTING INSTRUMENTS.

255,172. April 25th, 1925.—IMPROVEMENTS IN AND RELATING TO ELECTRIC METERS, Frank Holden, of 9, Winchester-road, Hampstead, N.W. 3, and Measurement, Ltd., of 7–17, Fitzalan-street, London, S.E. 11.

This invention relates to electricity meters of the mercury motor type in which a conducting bell or armature rotates in a body of mercury, while being acted upon by a magnetic field, the mercury cup or chamber being formed of some suitable mouldable insulating material. The object of the invention is to provide an improved construction of this type of meter. The external magnet ring A is formed of, say, tungsten steel, which may, for example, be formed from a bar of steel of correct length bent round and acetylene welded at the butt joint, the ring so formed after being hardened having its internal surface ground to the correct dimensions. The internal magnet B is formed of high-grade cobalt steel, and the two members A and B are imbedded in a cup-shaped mould C of some suitable mouldable insulating material such as that sold under the name "Bakelite," the members A and B being spaced apart to form an annular mercury chamber D. To permit of magnetisation

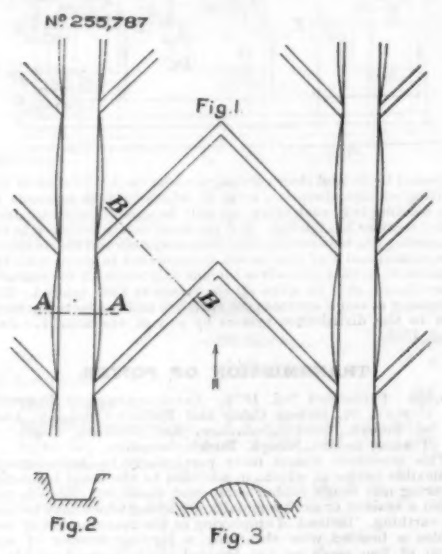


of the whole magnetic system when it has thus been assembled, means are provided whereby an electric current may be made to flow, so as to link with the magnetic system. This may be effected by providing a number of holes E in the moulding material arranged upon each side of the internal magnet, so that a conductor or conductors may be passed through them for the purpose of conveying the magnetising current, and after the magnetising operation has been completed the conductors may be removed, and the holes may then be closed in any convenient manner, as, for example, by screws or plugs, or by a plate covering them externally. Instead of providing a number of apertures, as shown, a number of conducting pins or plugs may be arranged in the material forming the cup, so that they are moulded therewith, these pins or plugs being utilised in connection with any form of jig or other contrivance adapted to complete the magnetising circuit. For the purpose of enabling a cover plate to be attached after completion of the operation described, a series of studs F, by which the cover plate may be secured, may be moulded in with the cup.—*July 22nd*, 1926.

CRUSHING AND GRINDING.

255,787. April 27th, 1926.—SUGAR CANE MILLS H. W. Aitken, Britannic House, Park-circus, Glasgow.

This is a development of the Krajewski rolls of a sugar mill, and the inventor claims that rolls made after his design crush the cane, squeeze out the juice and allow the juice to flow away

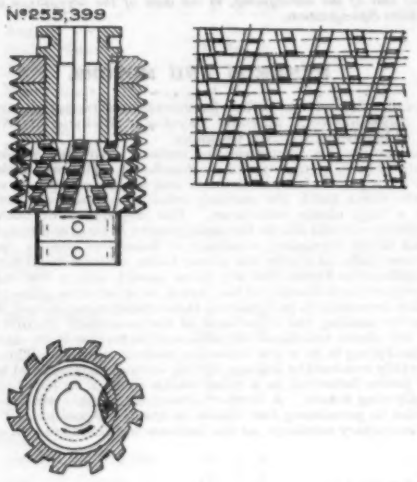


without being re-absorbed by the bagasse. In the drawings Fig. 1 is a development of the surface of the roll, while Fig. 2 is a section through A A and Fig. 3 is a section through B B. The co-acting roll is the reverse of that illustrated. It is suggested that the ridges shown in Fig. 3 should lie at an angle of 45 deg. to the axis, but may lie at any angle between 20 deg. and 70 deg. The grooves shown in Fig. 2 may be repeated at the intersections of the ridges.—*July 29th*, 1926.

MACHINE TOOLS AND SHOP APPLIANCES.

255,399. May 17th, 1926.—MILLING CUTTERS, Fried. Krupp Aktiengesellschaft, Essen, Germany.

This milling cutter is of the type having a steep helical pitch, and its peculiarity lies in the fact that the alternate teeth are right and left-handed. In order to make the spacing of the teeth



as close as possible, one set of the teeth is staggered, as shown, in the development. The cutter is built up of a number of discs, keyed on to a centre, to facilitate grinding. That illustrated is a hob for cutting screw threads.—*July 22nd*, 1926.

LIGHTING AND HEATING.

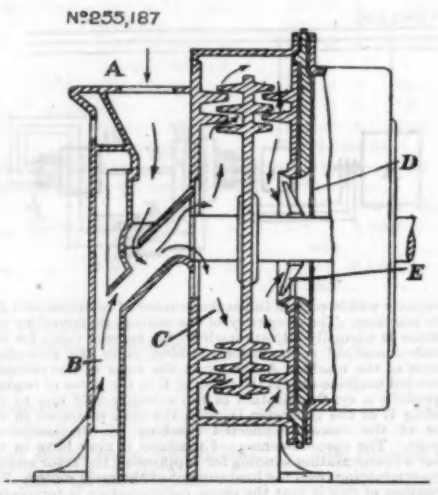
255,195. May 26th, 1925.—IMPROVEMENTS IN OR RELATING TO ELECTRIC RESISTANCE ELEMENTS, PARTICULARLY FOR USE IN INCANDESCENT LAMPS AND THERMIONIC DEVICES, The General Electric Company, Ltd., of Magnet House, Kingsway, London, W.C. 2, and Colin James Smithells, of Research Laboratories of the General Electric Company, Ltd., Wembley, Middlesex.

For many purposes it is desirable to provide a long length of fine wire contained within a small space and heated to a high temperature. One example is in the construction of gas-filled electric incandescent lamps for ordinary supply voltages; another is in the construction of indirectly heated cathodes for thermionic devices, in which a heating element designed for ordinary supply voltages has to be placed inside a small cathode. It has often been proposed to achieve this end by winding the fine wire upon some form of solid insulating support, but hitherto no such support has been known which will withstand the high temperatures involved. Quartz and magnesia have often been proposed. Quartz softens at about 1800 deg. K. and evolves gas at a considerably lower temperature, and magnesia, prepared by the previously known processes with which the inventors are acquainted, also evolves gas at that temperature, though it does not soften. It has now been found that supports of magnesia can be made which will withstand temperatures up to 2200 deg. K. or possibly more. According to the invention, magnesia suitable for this purpose is prepared by sintering magnesia powder at about 1800 deg. K. to form a compact body which undergoes no shrinkage on further heating; grinding the sintered magnesia; moulding the ground material, mixed, if necessary, with a small proportion of unsintered magnesia, into the finally desired form; and then heating the finally shaped articles above 3300 deg. K. by contact with, or by radiation from tungsten heated nearly to its melting point, so that the magnesia is fused on its surface. A relatively long length of wire, for example, tungsten wire, may be wound in a known manner on a small support made as described above. The element so formed may be used as a heating element—for example, for heating the cathode of a thermionic device provided with a known form of cathode adapted for indirect heating.—*July 22nd*, 1926.

MISCELLANEOUS.

255,187. May 16th, 1925.—COAL PULVERISING MACHINES, Sir A. Herbert, Dunley Manor, near Whitchurch, Hants, and E. Blyth, Stocton, near Rugby.

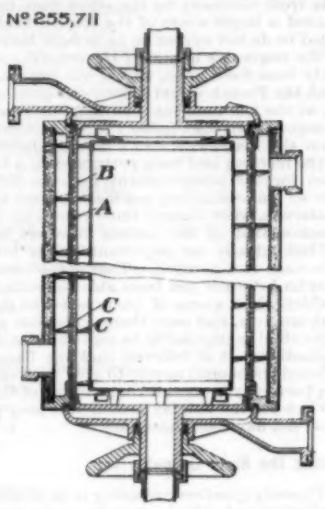
The object of this invention is to prevent the discharge from a pulveriser of particles of coal which have not been ground



sufficiently finely. The coal is dumped into the hopper A and is met by a draught of air, coming up the passage B, which carries it into the disintegrating chamber C, through which it passes, as shown by the arrows. At the outlet D from the chamber, a set of paddles E is attached to the shaft. It is claimed that the backwardly sloping form of these paddles results in the coarser particles of fuel being thrown back into the disintegrator for further grinding.—*July 22nd*, 1926.

255,711. December 5th, 1925.—HEAT EXCHANGERS, R. L. Munday, Tyne Villa, Bloomfield-road, Bath.

This invention is specially concerned with the pasteurisation of milk, but might be employed in a number of other directions. The apparatus comprises two sets of helical conduits through which the two fluids are passed. The passage for the milk, for instance, is formed by the shallow groove A on the surface of the



cylinder B, while the passage for the heating or cooling water is formed by the spaces between the helical flanges C C. The inside helix is of the opposite hand to those on the outside. The whole arrangement is enclosed by an insulating cover and appropriate end pieces are provided for the flow of the liquids. The various parts can be dismantled endways for cleaning.—*July 29th*, 1926.

Forthcoming Engagements.

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Wednesday of the week preceding the meetings. In all cases the TIME and PLACE at which the meeting is to be held should be clearly stated.

TODAY AND SATURDAY, AUGUST 28TH.

IRON AND STEEL INSTITUTE.—Autumn meeting at Stockholm. For programme see page 125.

SATURDAY, AUGUST 28TH.

NORTH OF ENGLAND INSTITUTE OF MINING AND MECHANICAL ENGINEERS: ASSOCIATES' AND STUDENTS' SECTION.—The Institute's Lecture Theatre, Newcastle-upon-Tyne. Paper, "The Mineral Wealth of the British Empire," by Captain W. Ridley. 3 p.m.

WEDNESDAY TO SATURDAY, SEPTEMBER 1ST TO 4TH.

INSTITUTE OF METALS.—Autumn meeting at Liége. For programme, see pages 45 and 181.

SATURDAY, SEPTEMBER 4TH.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS.—North-Eastern District meeting at Blyth. 12.30 p.m.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS.—South Wales District meeting at Llantrysant and District. 10.55 a.m.

SATURDAY TO SATURDAY, SEPTEMBER 4TH TO 18TH.

NATIONAL RADIO EXHIBITION.—Olympia, London. W. 1. 10.30 a.m. each day.

MONDAY TO SATURDAY, SEPTEMBER 6TH TO 18TH.

UNIVERSAL SMOKE ABATEMENT EXHIBITION.—Bingley Hall, Birmingham.

FRIDAY, SEPTEMBER 10TH.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS.—North-Eastern District meeting at Middlesbrough. 2 p.m.

TUESDAY TO THURSDAY, SEPTEMBER 14TH TO 16TH.

INSTITUTION OF PUBLIC LIGHTING ENGINEERS.—Annual meeting and Conference at Newcastle-upon-Tyne. For programme see page 229.

AWARDS TO AIRCRAFT APPRENTICES.—The Air Ministry announces that Aircraft Apprentices J. T. Stephenson (Croydon), J. Mutch (Dinnet, Aberdeenshire), W. B. Worstall (Swindon), A. L. Weaitt (Bexley, Kent), and F. Whittle (Leamington, Warwickshire), from No. 4 Apprentices' Wing, Cranwell; and Aircraft Apprentice C. B. Hughes (Deal), from the Electrical and Wireless School, Flowerdean, have been selected for cadetships at the R.A.F. Cadet College, Cranwell, on the results of the examinations held on completion of their three years' training as aircraft apprentices. "Sir Charles Wakefield" Scholarships, valued at £75 each, have been awarded to Flight Cadet H. R. Dale (Wharram, Malton, Yorks.), who obtained the fourth place in the recent competitive examination for entry into the Cadet College, and to Flight Cadet J. T. Stephenson. The "Hyde-Thomson" Memorial Prize, valued at about £33, has been awarded to Flight Cadet C. B. Hughes. In addition the "Sir Charles Wakefield" Scholarship, the award of which was deferred in November, 1925, has now been granted to Flight Cadet C. E. St. J. Beamish (Larne, Co. Antrim).